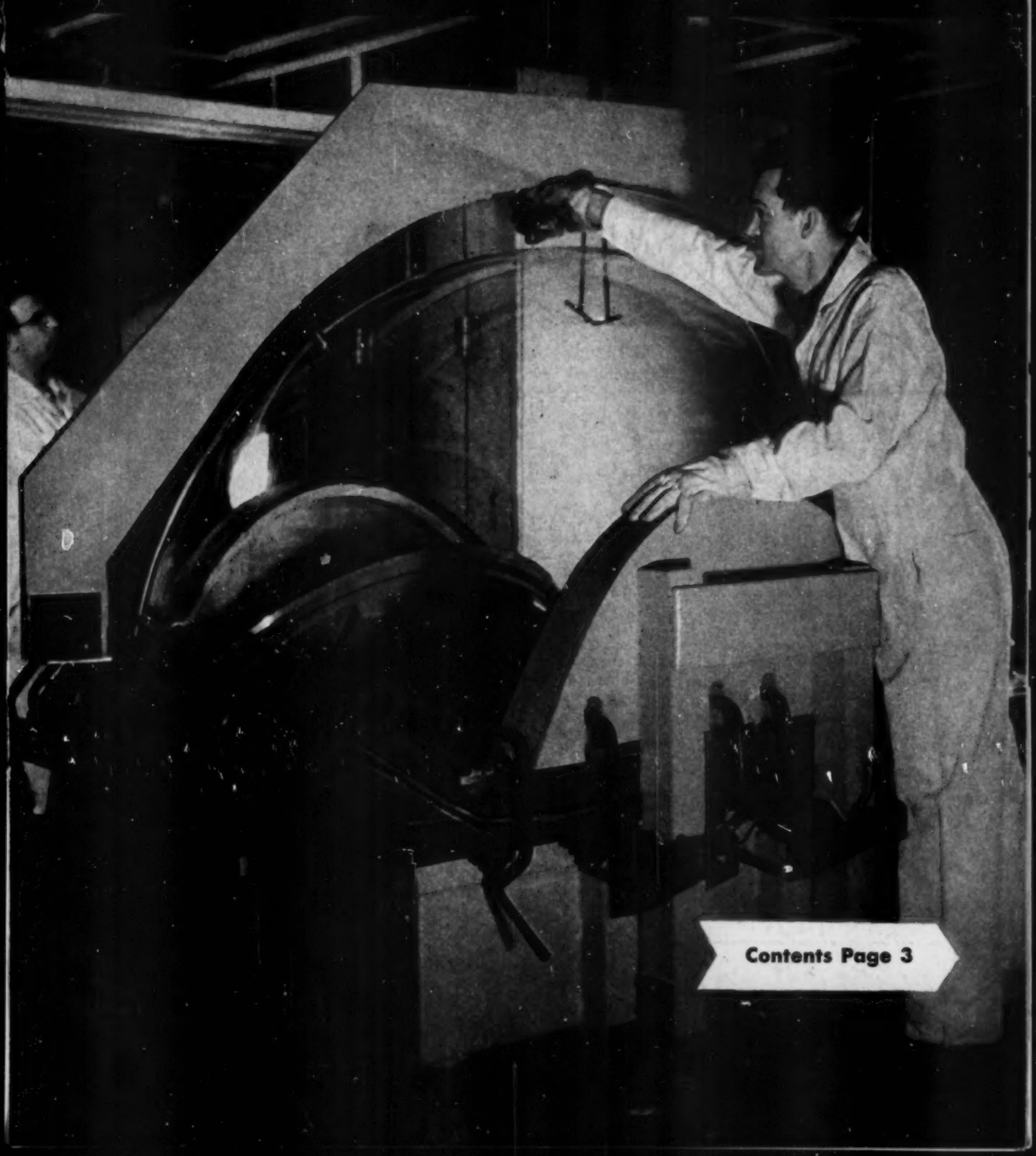
Product Engineering

A McGRAW-HILL PUBLICATION

Five Dollars a Year

AUGUST 1953



Contents Page 3

THE LEADERS LOOK TO THE LEADER

EASY WASHERS use C/R Oil Seals

One secret of the outstanding success of the Easy Washing Machine is the special oil used in the gear-case assembly. This lubricant is of so high a quality that it normally lasts for the entire life of the machine.

There can be no doubt, likewise, about the lifetime performance of the oil seal that keeps this fine oil in, and dirt out.

The day-in and day-out utilization of a washing machine over long years of household service is a severe test of all working parts. Easy Spindriers are famous for long and trouble-free performance. A C/R oil seal, with Sirvene synthetic rubber sealing member, guards this smooth functioning at the very heart of the machine —the gear case.

Another example of a leader looking to the leader, for research, engineering and manufacture of the highest type. If you have a particularly tough oil-sealing problem, where failure simply cannot be allowed to occur, put it up to Chicago Rawhide engineers. This sort of thing has been their specialty for 30 years.

C/R oil seals, the most widely used, are stocked in over 1800 sizes covering 16 different types, for immediate delivery. Our booklet, "Engineering with C/R Oil Seals," belongs in your files. Allow us to send it to you, without cost or obligation.

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● ***More automobiles, farm equipment and industrial machines rely on C/R oil seals than on any similar sealing device.***

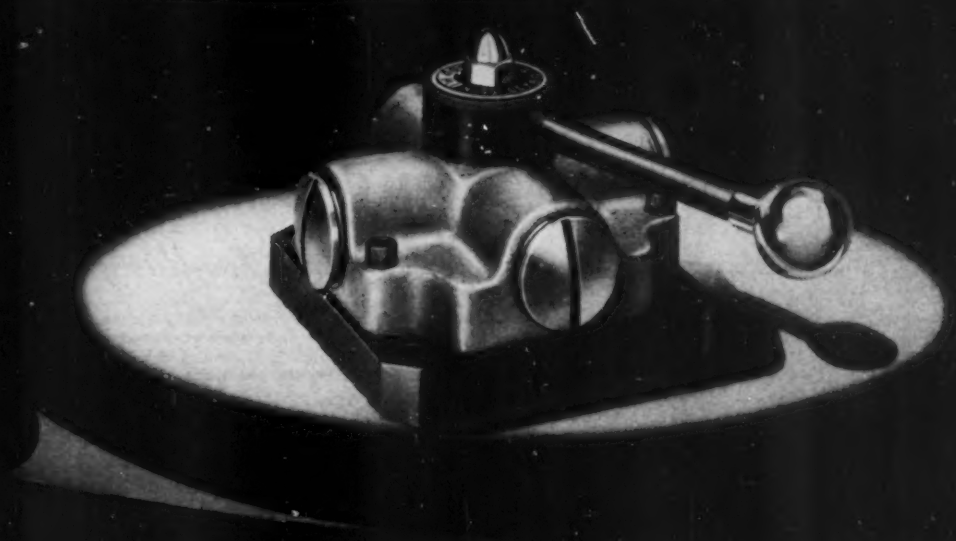
75 C/R

PERFECT Oil Seals

IT'S NEW . . .

IT'S FOR MACHINE TOOLS . . .

it's a "pancake"—2" high



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with Rotary Handle Action

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serve American Sanitary

Shown here are a few of the more than a thousand of American Sanitary plumbing goods made largely of Revere brass plumbers' tube. This tube is made by special techniques developed by the Revere Mills to assure easy fabrication into plumbers' items.

Almost every home in this great country of ours has plumbing. Most people never give a second thought to traps and bends and elbows, sink strainers, flanges and so on. But both Revere and American Sanitary Manufacturing Co., Abingdon, Illinois, think a lot about them. American Sanitary makes over a thousand such items for plumbing, and buys a great deal of Revere brass plumbers' tube, also hexagonal O.D., round I.D. heavy wall leaded brass tube for easy machining into fittings. The point about this long association between Revere and American Sanitary is that Revere uses special mill techniques to produce brass plumbers' tube. These techniques make it possible for American Sanitary to produce the bends, often at 180°, without cracking, without marring the finish. Thus nickel or chromium plating can be carried out successfully, and beautiful parts produced, the parts that householders admire, and which add to the value of both new and older houses. Thus, behind even the most taken-for-granted articles there is usually a lot of special skill and know-how.... If you would like to benefit from the capabilities of the Revere Mills, and of the Revere Technical Advisory Service, get in touch with the nearest Revere Sales Office. See your telephone directory, or write direct.

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Product Engineering

IN THIS ISSUE

Vol. 24, No. 8 August, 1953

Instruction Manuals by John W. Wight 141

Which Characteristics for Hydraulic Fluid? by B. B. Flick 149

Cemented Chrome Carbides by J. D. Kennedy 154

Product Designs 158

Break-Even Charts by W. A. Schuette 170

Turbine Pumps Have Their Niche by Arthur B. Olmore 172

Dynamic Braking of Squirrel Cage Motors by Samuel Noodleman 178

Basic Principles of Pneumatic Operators by Henry Milo 184

Jewel Bearings by R. P. Cameron, Jr. 186

Magnetic Drum Storage Devices by Robert L. Perkins 192

Curved Jaw Stretch Forming by J. S. Corral 196

Tensile Testing at High and Low Temperatures by K. W. Mitchell ... 197

Calculation of Dihedral Angles by William W. Johnson 213

Review Your Products for Economy by Rex Cleveland 282

Highlights	5	Technical News	204	Engineering Abstracts	268
Design Perspectives ...	135	New Parts and Materials	218	Sans, Souci	264
Editorial	139	Meetings	254	New Books	287
		New Catalogs and Bulletins	255		

ABP AUGUST, 1953 **Product Engineering** Vol. 24, No. 8 ABC

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THIS MONTH'S COVER

Blowing the acrylic "bubble" that forms the cockpit enclosure of Bell Aircraft Corporation's 47D-1, H-13G, and HTL-5 helicopters. Heated to 325F, an 81 x 79 in. x 5/16 in. thick sheet is sealed in the fixture and blown into shape by air at 95 psi pressure. Blowing takes 3 minutes, hardening requires 15 minutes. Kodachrome courtesy Bell Aircraft Corporation.

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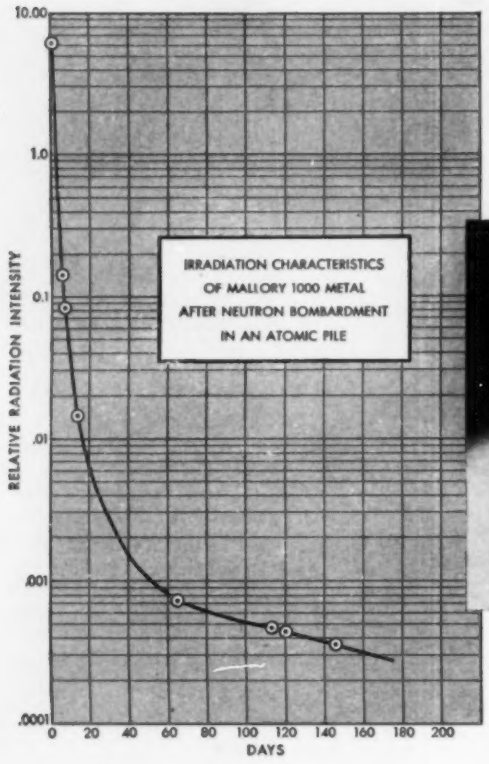
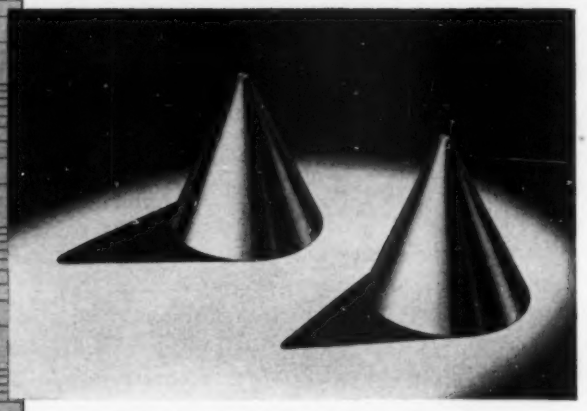
Mallory 1000 Metal...

An Effective Answer for Radioactive Shielding





Mallory 1000 Metal is a high-density, homogeneous alloy of tungsten, nickel and copper fabricated by special powder metallurgy methods that make it especially well suited for use as an effective radiation shielding material.

Recently, samples of Mallory 1000 were placed in the atomic pile at Oak Ridge, Tennessee, along with control samples of pure tungsten, nickel-tungsten and copper-tungsten. After being subjected to a high neutron flux density for four weeks, preliminary measurements indicated two primary radiation products: tungsten (187) with a 24-hour half life and tungsten (185) with a 74-day half life. Relative radiation intensity of the samples now, several months after removal from the pile, represents a tolerable time of more than 8 hours at working distances of 3 inches.

High voltage X-ray absorption tests have proved Mallory 1000 to have about 20% better absorption properties than lead when used as a shield for 100 MEV X-rays from a Betatron.

All the tests run by our physicists, engineers and metallurgists indicate Mallory 1000 to be suitable for use as containers for radioactive isotope storage. It is also a good shielding material for Betatron, Synchrotron and Cyclotron radiation.

In addition to its superior absorption properties, Mallory 1000 may be readily machined to complicated shapes, within close tolerances and with excellent surface finish.

For complete information on Mallory 1000 Metal, write to Metals and Ceramics Division, P. R. Mallory & Co. Inc., Indianapolis, Indiana.

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P. R. MALLORY & CO. INC., BATTERY DIVISION, NORTH TARRYTOWN, N.Y.

For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio.

Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear.

METALLIC MATERIALS

ALUMINUM BASE ALLOY . . . .

. . . . To be used for electrical conductors, an aluminum base alloy made from 99.95 percent pure Al, 0.43 percent Fe, 0.32 percent Mg and 0.10 percent Si is reported to be superior to the EC grade of aluminum. Known as Cond-Al, General Electric Co., Schenectady, New York reports the material has better creep resistance, twice the yield strength and an electrical conductivity of 58.5–60.0 percent as compared to 61.5–62.5 percent for the EC grade. Fatigue strength of Cond-Al is 10,000 psi at 10^8 cycles.

ALTERNATE STAINLESS STEEL . . . .

. . . . Alternate stainless steel, containing Mn, Cr and less than one percent Ni, offers good cold working properties, weldability and ductility. Allegheny Ludlum Steel Corp. claims the steel can be used in applications where critical requirements include the mechanical properties of welds, ductility, non-magnetic qualities and cold working to high strength. The austenitic steel can not be used where extreme corrosive conditions exist.

STAINLESS ALLOY . . . .

. . . . High corrosion resistance, hardenability, and machinability in the quench-annealed condition are characteristics of a new V2B stainless alloy. Copper Alloy Foundry Co., Hillside, N. J., reports that the material contains Cu, Mo, Si, and a small amount of Be. After machining the steel can be precipitation hardened by low-temperature heat treatment, which produces no distortion and only a light tinting discoloration that can be readily removed. The alloy does not overage at elevated temperatures it is claimed, and can be produced in both cast and wrought form. Suggested applications are for valve disks, pump impellers, gears and other wearing parts.

GOLD USED FOR INDUSTRIAL PLATING

. . . . Gold plating is done from a high cyanide low-temperature electrolyte having a gold metal concentration of about one troy oz. of metal per gal. Sel-Rex Precious Metals, Inc., Belleville, N. J., reports that hard bright deposits of 0.001 in. and thicker are obtained without difficulty regardless of shape or size of the piece. The solution is mechanically agitated and operates at normal current densities. Cathode efficiency is said to be 100 percent, thus allowing accurate deposition of plate thickness to meet exact specifications. In the electronic field, gold resists tarnishing, oxidation and corrosion and prevents wear on radar and telephonic parts, including sliding and wiping contacts.

POROUS STAINLESS STEEL . . . .

. . . . Porous steel is being considered for possible application in the nose portion of jet engine air intakes, to reduce high skin temperatures and on the leading edges of wings and tails. Aircraft Porous Media, Inc., Glen Cove, N. Y., claims that a type 316 steel sheet with 35-40 percent voids has a tensile strength of 35-55,000 psi and a modulus of elasticity of about 15,000,000 psi. An 0.040 in. porous skin will allow a flow of 40 cfm/sq ft at a pressure drop of two psi or 20 cfm/sq ft with a drop of one psi. The material can be formed to a radius three times the material thickness and mild drawing is possible. First installation is to be made on a Consolidated Vultee Aircraft Corp. F-102 high speed delta wing interceptor.

NONMETALLIC MATERIALS

TOUGH SILICONE COATING . . . .

. . . . Silicone rubber coating, useful for avionic and other applications, is claimed to have greater toughness and higher dielectric rating than other coatings. GE reports that its rated physical and electrical strength are retained from —60 to 316 C. It can be used for engine gaskets and flexible heater ducts and wide application is expected in Class *H* insulation in equipment exposed to moist, hot conditions.

NEW SYNTHETIC RUBBER . . . .

. . . . The basic ingredients of the polyester rubber are ethylene glycol and propylene glycol. The polyester is then treated with diisocyanate which stops the solidifying reaction of the chemicals; the amount determined by the "reaction factor", the secret of the development. The Goodyear Tire and Rubber Co., Akron, Ohio claims the rubber has twice the abrasion resistance of the best cold rubber, stands up against oil as well as neoprene and resists oxidation with the best butyl and acrylate rubbers. Its tensile strength is 50 to 100 percent greater than other types of rubber-like materials.

GASKETING MATERIAL . . . .

. . . . A gasketing material, said to be equally effective at high or low temperatures is a development of the Joclin Manufacturing Co., Hamden, Conn. Called Fluorlastic gaskets, the material is a combination of

(continued on page 7)

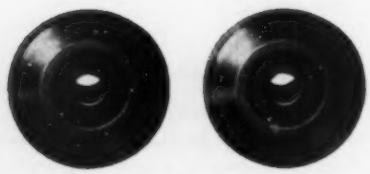
Squeeze Play on Plastics

modernfold DOORS

ACCORDION DOORS--

Pulled by Handles-- Rolled on Trolleys

by KURZ-KASCH



The Newcastle Products Company, originators over a decade ago of the Modernfold Door, gave to modern architecture its soundest solution of space saving. Miraculous walls that close for privacy —open for that feeling of space! Doors that fold compactly instead of sweeping the room (and the furniture before it).

This successful company with its unique contribution to a brighter plan of living has depended on Kurz-Kasch for its moulded plastics for over a decade. We have contributed, too—sound advice on *proper* plastics applications; sensible tooling; economical production—in short, everything it takes to earn a reputation as a solid source of supply. Want to try us? For information or a proposal, just write or phone.

Kurz-Kasch, Inc. • 1427 S. Broadway • Dayton 1, Ohio

BRANCH SALES OFFICES: New York, Lexington, 2-6677 • Rochester, Hillside 4352 • Chicago, Merrimac 7-1830 • Detroit, Trinity 3-7050 • Philadelphia, Hilltop 6-6472 • Dallas, Logan 1970 • Los Angeles, Richmond 7-5384 • St. Louis, Delmar 9577 • Toronto, Elgin 4167
EXPORT OFFICE: 89 Broad Street, New York City, Bowling Green 9-7751.

Kurz-Kasch

FOR OVER 36 YEARS PLANNERS AND MOULDERS IN PLASTICS

Teflon and silicone rubber. It consists of long strips of foamed silicone rubber wrapped in sheets of Teflon and then heat sealed to form an impenetrable envelope. Units are intended for use in the chemical, pharmaceutical and aircraft industries.

IRON POWDER DIES . . . .

. . . . Iron powder mixed with Epon resin can be used to increase the life of plastic dies. Kish Plastic Co., Lansing, Michigan, claims the material does not become brittle, has a high resistance to abrasion and increases die life. Dies can be used to make parts from aluminum and stainless.

COMPONENTS

PRESSURE REGULATOR . . . .

. . . . A regulator that maintains pressure at a constant level regardless of altitude is a development of the Accessory Products Co., Whittier, Calif. The regulator uses a system of valves that are controlled by aneroid bellows. It can compensate for leakage in excess of 200 cu in. per min, is suitable for inlet pressures from 20 to 1,500 psi and temperatures from —65 to 165 Fahrenheit.

NON-SHORTING ROTARY SWITCH . . . .

. . . . A single pole rotary switch for the control of complicated circuits in experimental equipment is the design of the Shallcross Mfg. Co., Collingdale, Pa. The switch, designed for 36 or 60 positions, has a current capacity of 30-40 amps. The rotor arm lifts from contact to contact, instead of sliding, allowing closer spacing between contacts without shorting.

PLANETARY GEAR REDUCER . . . .

. . . . A miniature motor-driven planetary gear reducer designed to provide maximum output in the smallest space has been developed by Globe Industries, Inc., Dayton, Ohio. The torque output varies with the gear reduction up to a maximum continuous of 1,000 oz-in. Gear system ratios from 17.8:1 to 21,808:1 are possible using a 1/100 to 1/150 hp permanent magnet d-c motor. The planetary system uses less space than a spur gear reduction system.

AIR OPERATED CIRCUIT BREAKER . . . .

. . . . Shop air lines supplying pressures of 65 to 100 psi will operate a new compressed air circuit breaker developed by Westinghouse Electric Co. The breaker is for arc furnace switching use and with normal maintenance should operate for two years before replacing contacts or mechanical parts.

SHOCK MOUNT . . . .

. . . . A special shock mount designed for severe vibration and acceleration has been developed by Robinson Aviation, Inc., Teterboro, N. J. It is designed for isolation vibration and shock for positive, negative and radial loads and uses an all-metal cushioning material. Features claimed for the mount are non-linear deflection, high damping, low amplification at resonance, and good temperature characteristics. Load ranges are 1 to 7 pounds.

CONTROL TO MONITOR ATOMIC PILES . . . .

. . . . A packaged automatic control system to monitor operation of atomic piles and their related processes is a design of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa. System includes electronic instruments to control rate of power generation by regulating reactor's control rods. System is expected to be valuable when linked to other automatic equipment for conversion of nuclear power into electric power.

PROCESSES

MEASUREMENT OF PLATED SURFACES....

. . . . Thickness of a plated surface has been determined with a test setup by the anodic solution method. King-Seely Corp., Ann Arbor, Michigan, states the method is based on the principle of electrolytic solution or stripping of a definite plated area with a known amount of current. Accuracy is claimed to be ± 5 percent.

TAPPING TITANIUM . . . .

. . . . Cooling, lubrication and removal of chips are the three principal problems involved in the tapping of titanium. Titanium work hardens rapidly, tends to gall, has a low coefficient of expansion and poor heat conductivity which aggravate the problem. Studies by the Hanson-Whitney Co., Hartford, Conn., report that properly ground taps and operating at surface speeds of 20 ft per min, using sulfur concentrate or fat oils to which chlorine has been added, allows the satisfactory tapping of titanium under commercial conditions.

MANGANESE RECOVERY . . . .

. . . . The recovery of manganese from steel furnace slags and low-grade ore deposits is under investigation by The Bureau of Mines. Processes showing the greatest promise are flotation and hydrometallurgy and pilot plants are operating at Boulder City. Investigations are aimed at developing better and cheaper methods of manganese recovery as the U.S. is now dependent upon imports for 90 percent of its requirements.

(continued on page 9)

for 38 Years . . .

Industry has come here for the finest in surface treatments of metals

Want a more durable, more attractive paint finish on your metal product . . . to cold form metal more efficiently, more economically . . . to protect iron and steel parts from rust . . . to assure smooth break-in and long service on friction parts?

Parker Rust Proof has products which will produce these benefits for you. Bonderite anchors paint to metal. Bonderite and Bonderlube are helping to revolutionize cold forming. Parco Compound controls rust. Parco Lubrite retards wear. They're all *proven* products, easy to use, dependable, uniform in results.

Back of every Parker product and its performance in your plant is our thorough knowledge and wide experience in surface treatments for metals. All we've learned in 38 years goes to work for you when you *call on Parker.*

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BONDERITE corrosion resistant paint base

BONDERITE and BONDERLUBE aids in cold forming of metals

PARCO COMPOUND rust resistant

PARCO LUBRITE wear resistant for friction surfaces

Highlights ~

CHROMIUM PLATING . . . .

. . . . Crack-free chromium can be deposited by using a special chromic bath. United Chromium, Inc., Detroit, Mich., claims the plate remains crack-free when heated to 1,000 F and in salt spray tests a 0.003 in. thick coat showed only scattered pin points of rust after 100 hr. Plate is dull but can be buffed to a high finish and will withstand high external stresses.

OIL-TIGHT CASTINGS . . . .

. . . . A fully automatic process for sealing porous aircraft engine castings with liquid synthetic resin is being used by Pratt and Whitney Aircraft, North Haven, Conn. The process is claimed to make aluminum and magnesium castings oil-tight through vacuum-pressure impregnation. After cleaning castings are placed in 1,500 gal autoclaves under 28 in. vacuum to eliminate air pockets and then a resin, 3255 Permafil, is introduced under light pressure.

SILICON PRODUCTION . . . .

. . . . A process for the manufacture of pure silicon has been developed by the duPont Co., Wilmington, Delaware. Output of the pilot plant is now great enough to supply extensive research programs in the fields of electricity and electronics. Silicon is able to withstand higher temperatures and handle more power than other semi conductors, and may be a replacement for germanium in transistors.

TESTING

TV FOR TEST CELL VIEWING . . . .

. . . . The application of television for scanning the operation of gas turbines and components is being studied at Pratt and Whitney Aircraft's Willgoos Laboratory. A compact industrial TV camera is being used and a distortion-free picture is received in the test cell over 1,000 ft away using a ¼ in. dia coaxial cable. Improved lighting in the test cell and batteries of cameras will permit scanning of the engine from all angles.

WIND TUNNEL . . . .

. . . . 2,500 mph speeds are forecast for the wind tunnel being constructed at the Arnold Engineering Development Center, Tullahoma, Tenn. Five compressors are driven by 4 motors whose combined 216,000 hp operate in a common system. Two of the motors are rated at 83,000 hp for 600 rpm. One circuit will produce speeds ranging up to 1 3/5 times the speed of sound (Mach number 1.6), and the other circuit will produce speeds up to 3½ times the speed of sound (Mach number 3.5). Air flow into the inlet of the compressor will be 13,000,000 cfm.

TIN THICKNESS GAGING EQUIPMENT . . .

. . . . By using the X-ray principle, The Applied Research Laboratories, Glendale, Calif., is producing a gage that will measure the thickness of tin on steel to accuracies of one millionth of an inch. The measurements are automatically made while the material is traveling at high speed as a continuous sheet. The instrument is claimed to have many applications to plating and gaging problems in the tin can, aluminum foil and other fields.

RESEARCH ON ALUMINUM PLATE . . . .

. . . . Investigation into the possibility of electroplating steel with aluminum is being done by the Virginia Polytechnic Institute. If a method can be found aluminum coatings could be applied to steel for the protection of parts against scaling and corrosion at elevated temperatures.

TENSION TEST EXTENSION INDICATOR . . .

. . . . New indicator for measuring extension under load in tension test specimens and for controlling auxiliary devices automatically is a development of Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. Indicator delivers signals at preset valves of extension. Signals are visual, audible and electrical.

ANALYZER FOR OILS . . . .

. . . . Lubricating oils can be analyzed for metallic contaminants with speed and accuracy by using spectrographic equipment with a direct-sparking Rotrode. Designed by Allied Research Laboratories, Glendale, Calif., method eliminates ashing technique usually associated with this type test. Routine analysis of lubricating oils, it is claimed, can be made at any time because of methods speed and economy.

TEST OSCILLOGRAPH . . . .

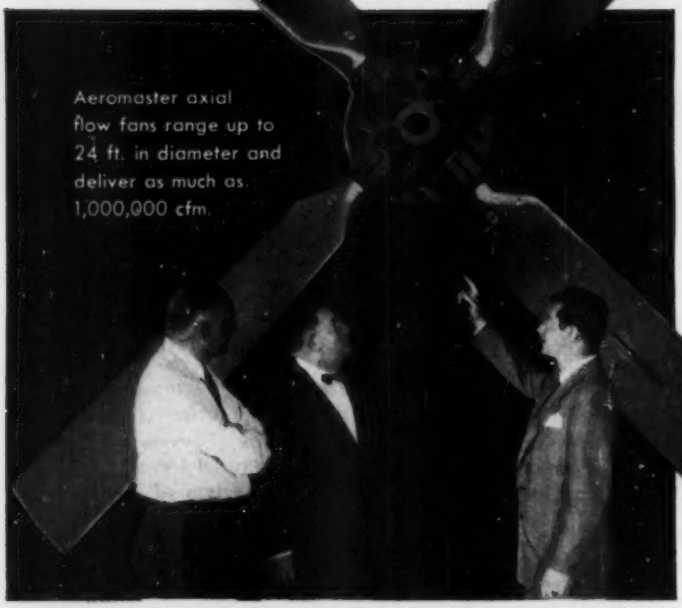
. . . . A lightweight oscillograph with 14 individual data channels and operating on 24-28 v d-c has been designed by Midwestern Geophysical Laboratory, Tulsa, Okla. Recording speeds of 1, 3, 6½, 13 and 32 in./sec. are available by gear changes and higher speeds can be obtained if desired. The unit weighs 16 lb and will hold 100 ft of paper in its magazine.

MOBILE X-RAY UNIT . . . .

. . . . Unit is designed for rapid field inspection of welds, industrial equipment, power plants and other apparatus. North American Philips Co., Inc., Mount Vernon, N. Y., reports that the unit has a high tension 150,000 v output generator within the head of the x-ray tube. Entire assembly, complete with controls, weighs 223 lb and is claimed to be the smallest and lightest unit to be designed.

DUCTALLOY® CASTINGS GIVE KOPPERS FANS

Strong, Sound Hubs



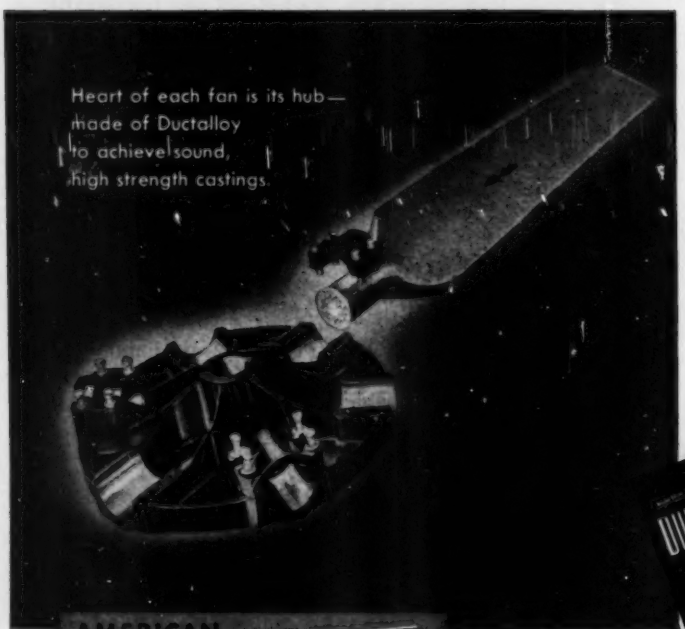
Aeromaster axial flow fans range up to 24 ft. in diameter and deliver as much as 1,000,000 cfm.

EASILY CAST, EASILY MACHINED

High performance fans made by the Aeromaster Fan Department of Koppers Company, used in cooling towers near diesel engines and compressors, must withstand considerable applied vibration in addition to normal operating loads. For this reason cast steel was originally specified to provide the necessary hub strength; but machining costs were excessive, surfaces were poor, and too many castings were "lost" when machining revealed hidden defects. A switch to malleable iron only aggravated the problem of casting soundness. The answer was Ductalloy 60—Brake Shoe's easily machined high strength ductile cast iron.

MACHINE SHOP REJECTS ENDED

Ductalloy 60 is a ferritic iron having 60,000 psi minimum tensile strength, 40,000 psi minimum yield strength and 10% minimum total elongation, all guaranteed. Use of this material has virtually eliminated the high scrap loss formerly encountered when defects were uncovered during machining of castings made in either steel or malleable iron.



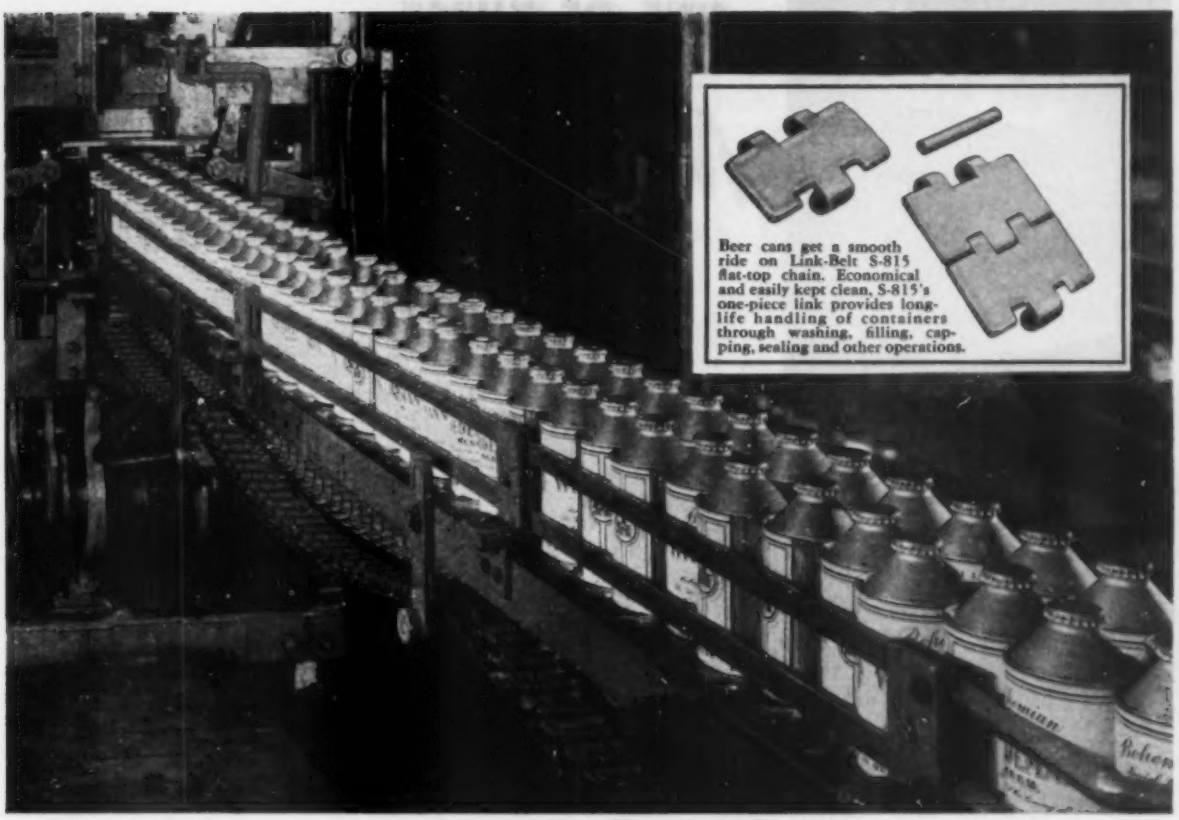
Heart of each fan is its hub—made of Ductalloy to achieve sound, high strength castings.

your problem — Ductalloy may solve your problem if it involves economical production of complex metal shapes that are difficult to cast in steel, expensive to forge or lacking strength in gray iron. Brake Shoe's experience, research laboratory and experimental foundry are available to help you best utilize Ductalloy's unusual combination of characteristics. Write for this new technical bulletin today.

DUCTALLOY castings are made by:
BRAKE SHOE & CASTINGS DIVISION
ENGINEERED CASTINGS DIVISION

AMERICAN **Brake Shoe** COMPANY

230 PARK AVENUE
NEW YORK 17 • NEW YORK



Beer cans get a smooth ride on Link-Belt S-815 flat-top chain. Economical and easily kept clean, S-815's one-piece link provides long-life handling of containers through washing, filling, capping, sealing and other operations.

Here's a smooth-operating, flat-top conveyor chain... moderately priced

LINK-BELT offers the chain that's best for every job

THE many varied drive and conveying jobs performed by chains and sprockets require different physical characteristics. The S-815 flat-top conveyor chain is an example of how Link-Belt builds a type and size for every purpose.

In addition, every chain in the complete Link-Belt line is built for longer life. Rigid control of raw materials and manufacturing processes is your assurance of uniformity.

For all the facts on S-815 flat-top conveyor chain, ask for Folder 2344. And for information on the complete Link-Belt chain line, see your nearest Link-Belt district sales representative.

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle; Scarboro, Toronto and Elmira, Ont. (Canada); Springs (South Africa); Sydney (Australia). Sales Offices in Principal Cities.

LINK-BELT

CHAINS AND SPROCKETS

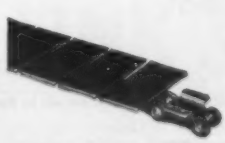
19,835

No one chain serves every purpose . . . get the RIGHT one from Link-Belt's complete line

Class RC crescent flat-top chain—travels in horizontal planes, around corners; ideal for bottles and cans.

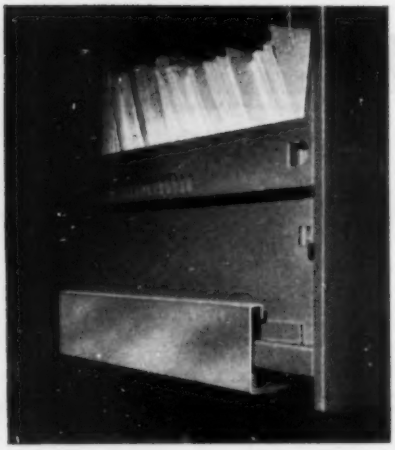
Malleable roller chain for conveyors or inclined elevators where reduced chain pull is desired.

Class 400 swivel chain—carries cartons, cases, etc. over paths with both vertical and horizontal turns.



Class RC flat-top chain—precision made for smoothest, spill-free carrying and long life.

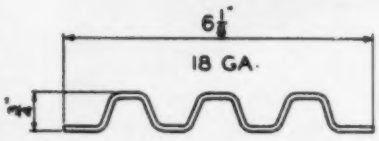
Class RC universal crescent flat-top chain can be used for multiplane operation traveling variety of paths.



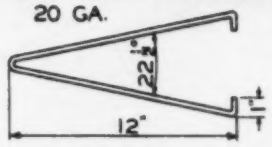
ONE OF THESE

MAYARI R SHAPES

MAY GIVE YOU AN IDEA



MILL LENGTHS



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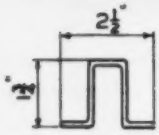

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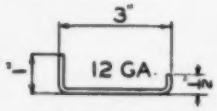

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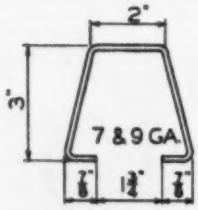

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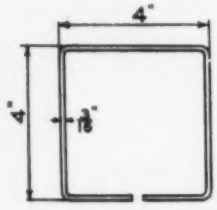

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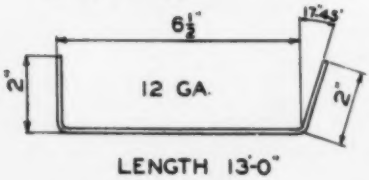

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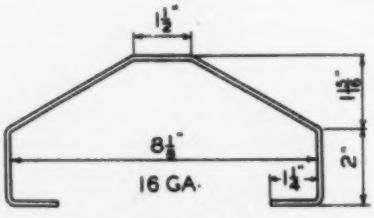

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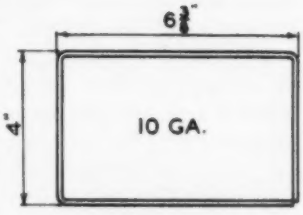

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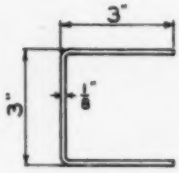

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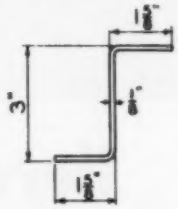
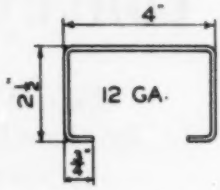


MILL LENGTHS



LENGTH 13'-0"

There are dozens of product applications for Mayari R cold-formed shapes . . . metal furniture . . . refrigerators . . . door tracks . . . storage racks . . . hand rails . . . curtain tracks . . . conveyor systems . . . and many others that will occur to you when you study these drawings.

These shapes are formed or rolled to the exact dimensions you require, without any waste material. They are easy to cut and assemble. And they can be welded by the usual methods used for carbon steel.

Mayari R, our low-alloy, high-strength steel, has a yield point of 50,000 psi minimum, almost twice that of plain carbon steel. This means that lighter gages can be used to reduce deadweight without sacrificing strength. Mayari R also has from 5 to 6 times as much resistance to atmospheric corrosion as plain carbon steel, and 2 to 4 times that of copper-bearing steel.

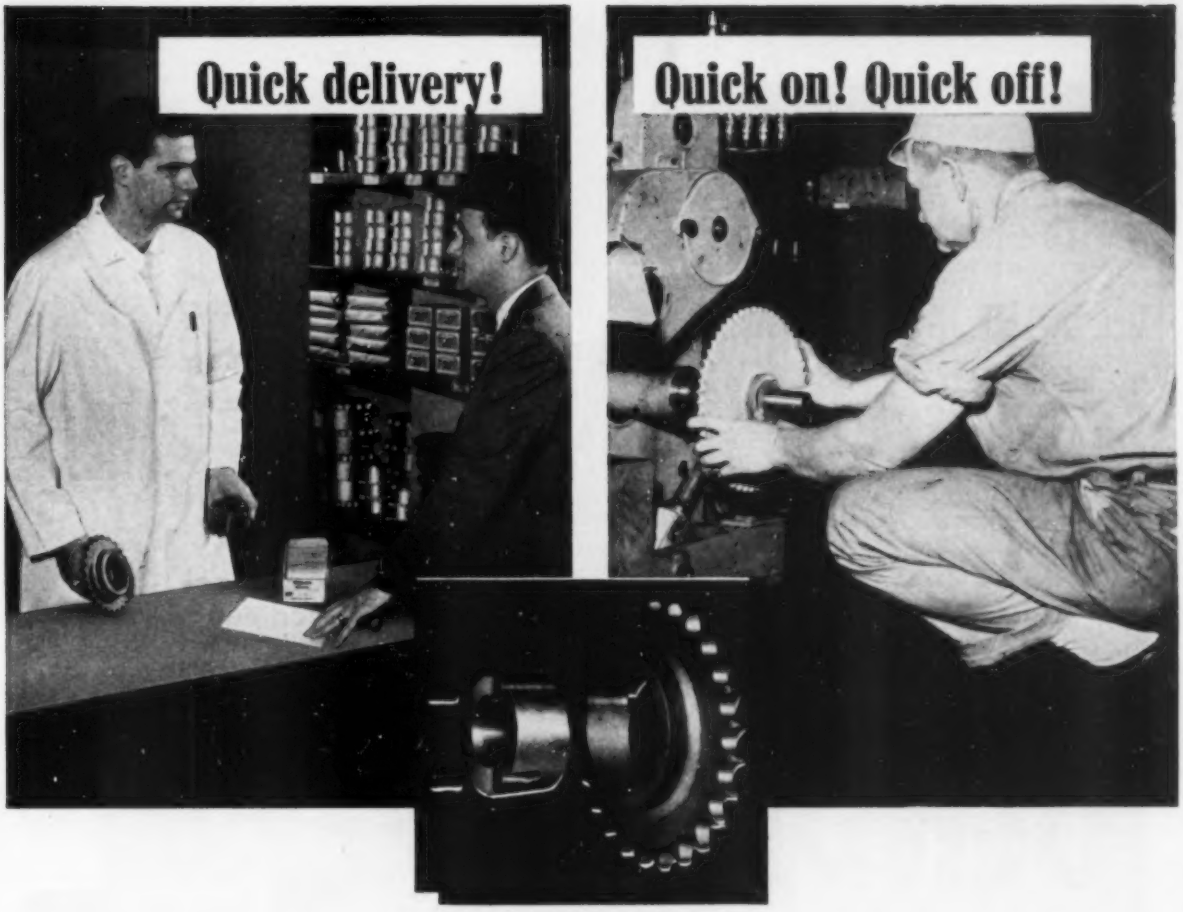
Consider these made-to-order sections with the thought of improving the design of your products, reducing deadweight, or cutting production costs. We'll be glad to help you work out a shape that will meet your needs. Get in touch with any Bethlehem sales office, or write to us at Bethlehem, Pa.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

Mayari R *makes it lighter... stronger... longer lasting*

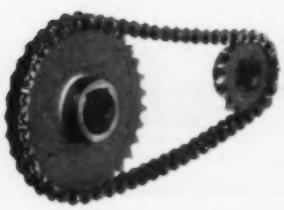


Link-Belt roller chain sprockets with taper lock bushings

HERE'S great news for users of roller chain drives! With the new Link-Belt taper lock sprocket, you don't have to fit the sprocket to the shaft. These sprockets with their taper lock bushings give you the equivalent of a shrink-fit on all standard shaft sizes.

Installation and removal are fast, simple. Set screws force and hold bushing in tapered bore of sprocket, *clamp* it tightly onto shaft. The *full length* of the bushing supports the sprocket on the shaft. Turning set screws in removal holes quickly releases it from shaft.

What's more, it's no longer necessary to wait while wheels are rebored. You can pick these sprockets right off the shelf at your nearby Link-Belt distributor or factory branch store. Available now are sizes for ½, ⅝, ¾, 1 and 1¼-in., single-width chains with other sizes to be announced. Ask for Bulletin 2449.



AN IDEAL COMBINATION:
LINK-BELT PRECISION STEEL ROLLER CHAIN & LINK-BELT SPROCKETS

LINK-BELT

ROLLER CHAIN AND SPROCKETS

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle; Scarboro, Toronto and Elmira, Ont. (Canada); Springs (South Africa); Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 53.201

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There is no need for inflation in small engine operating and maintenance costs if you specify Bendix magnetos. The fact is, a new high in dependable performance can be obtained at no extra cost. The basic design of these rugged lightweights enables Bendix to meet the operating problems of *every type* of small engine, as well as *every pricing requirement.* If you want to hold down operating costs for the small engines you employ, be sure to insist on Bendix—the most trusted name in magnetos. Write us for full details.

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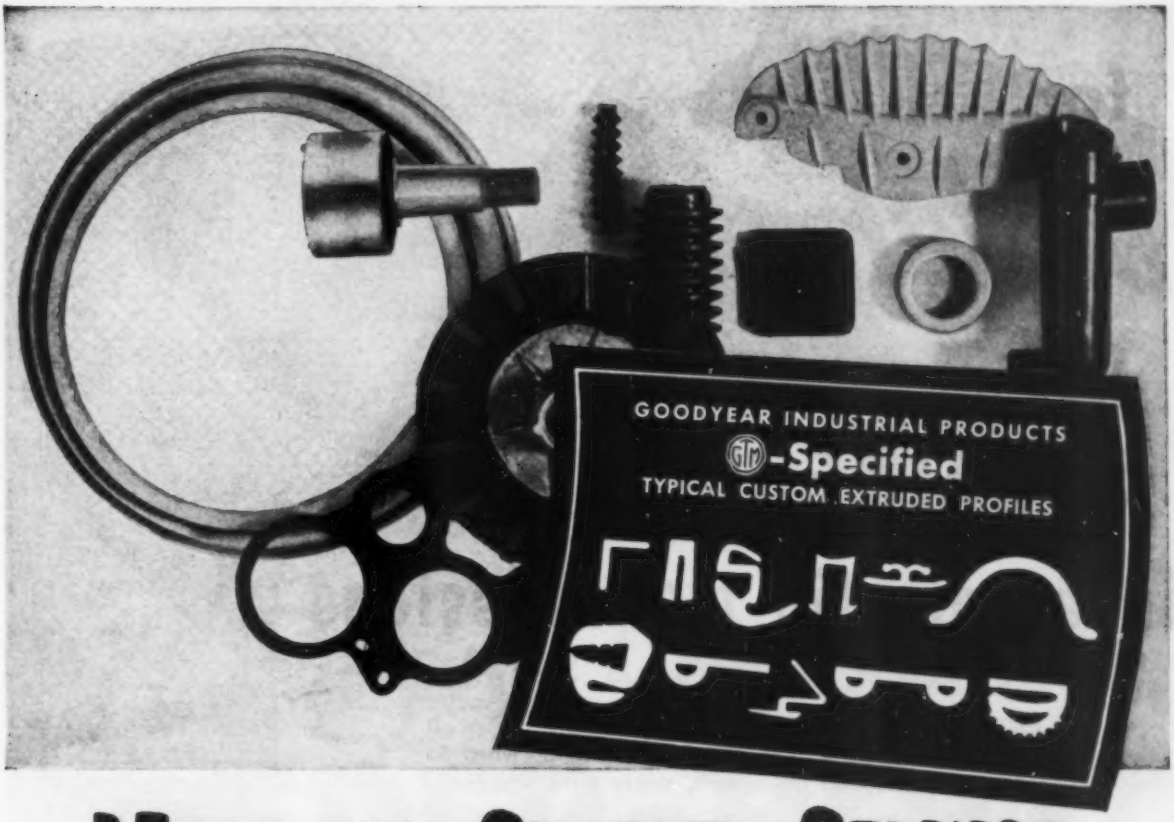

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through greater service

Greater service from custom molded or extruded rubber parts comes from the greater service Goodyear gives you throughout their design and production.

From drawing board to delivery, your product gets the special attention of Goodyear's experts in getting the most out of rubber.

The G.T.M.—Goodyear Technical Man—serves you with his long and varied experience in designing rubber to do a better job longer in many uses in many industries.

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For greater service from parts made of rubber or rubber-like plastics—or combinations of rubber and metal, rubber and fabric or rubber and plastic, use the greater service offered by Goodyear. Consult your G.T.M., or write to Goodyear, Molded Goods Dept., St. Marys, Ohio or Los Angeles, California.

YOUR GOODYEAR DISTRIBUTOR *can quickly supply you with Hose (air, water, steam, oil, special), Belting (V-belts, transmission, conveyor, elevator), and other industrial rubber products. Look for him in the yellow pages of your telephone directory under "Rubber Products" or "Rubber Goods."*

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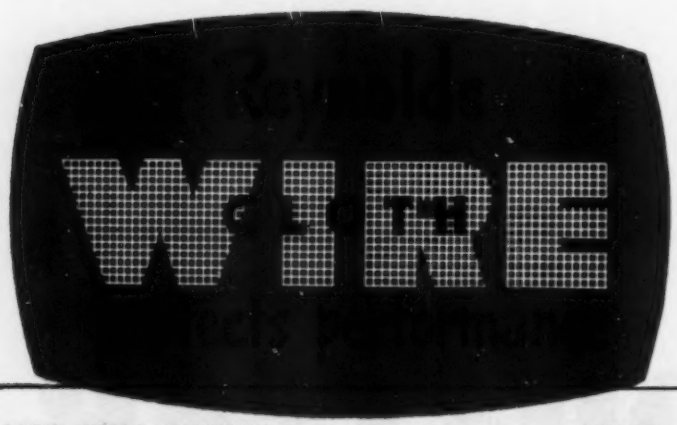
Cleaner oil betters performance, lengthens life. But an oil strainer can be no better than its wire cloth. So what? So *what* wire, or rather *whose* wire, makes a big difference.

Reynolds Wire Cloth is made to meet special-needs demands—all the way! From metal to mesh . . . from wire to weave . . . from ductility to durability. Its specifications are *your specifications*—its quality matches your products' quality. In any industrial application — automotive to agricultural.

Fifty-four—that's the measure of Reynolds wire cloth manufacturing experience, *in years.* By any other yardstick Reynolds measures up—from research to reliability. Put your problem to Reynolds engineers. No cost or obligation.

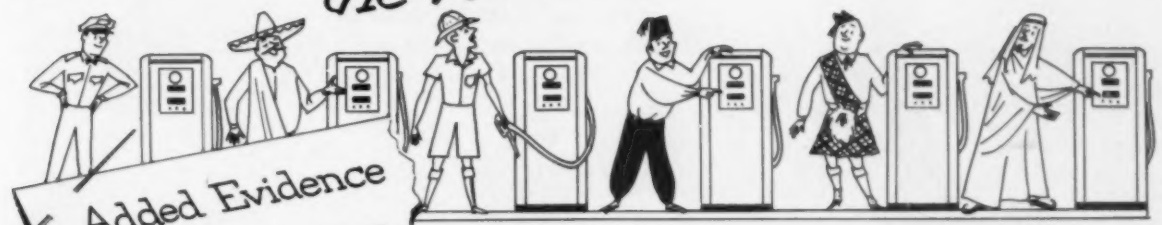


REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., **DIXON, ILLINOIS**

Divisions of National-Standard Co.

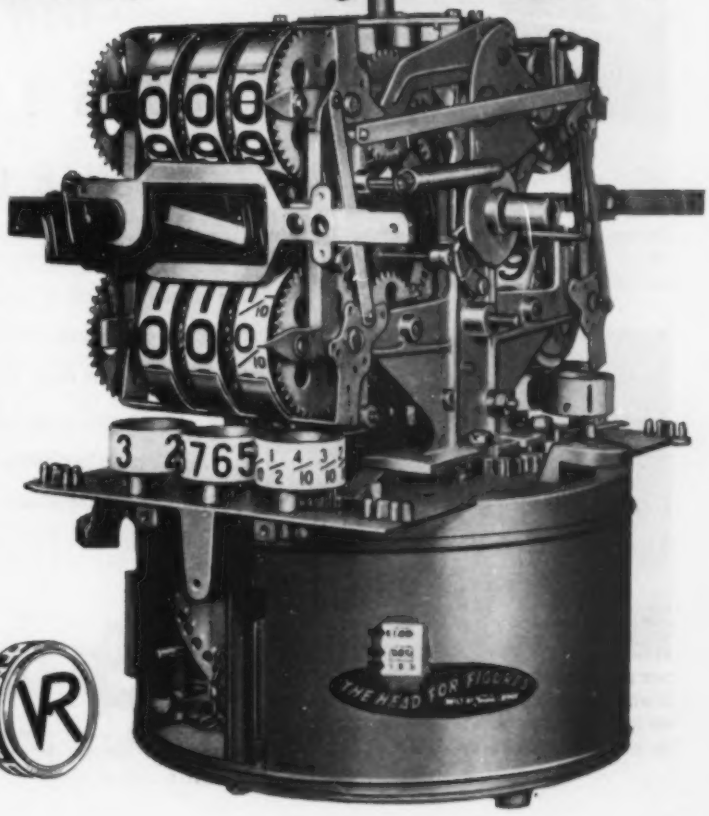
ATHENIA STEEL	*Clifton, N. J.*	Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD	*Niles, Mich.*	Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY	*Jersey City, N. J.*	Metal Decorating Equipment
WORCESTER WIRE WORKS	*Worcester, Mass.*	Round and Shaped Steel Wire, Small Sizes

It Computes the Cost of Gasoline Pumped... in All of the World's Currencies



Added Evidence that

Everyone Can Count on VEEDER-ROOT



Yes, this Veeder-Root Gasoline Pump Computer speaks the languages of 144 countries! A rugged, accurate mechanism of 800-plus parts, it's the modern protection given you by gasoline pump manufacturers, gasoline refiners and their service-station outlets . . . *to make sure you get full measure in your tank, and the right change in your pocket* (or you can buy in "even money"). And what's more, it underscores the fact that "Veeder-Root Counts Everything on Earth" . . . electrically, mechanically or manually . . . with standard and special devices of every conceivable type. Do *you* have a counting problem, in any of your defense work or any of your regular production? If so, you can count on V-R to help you in every possible way.

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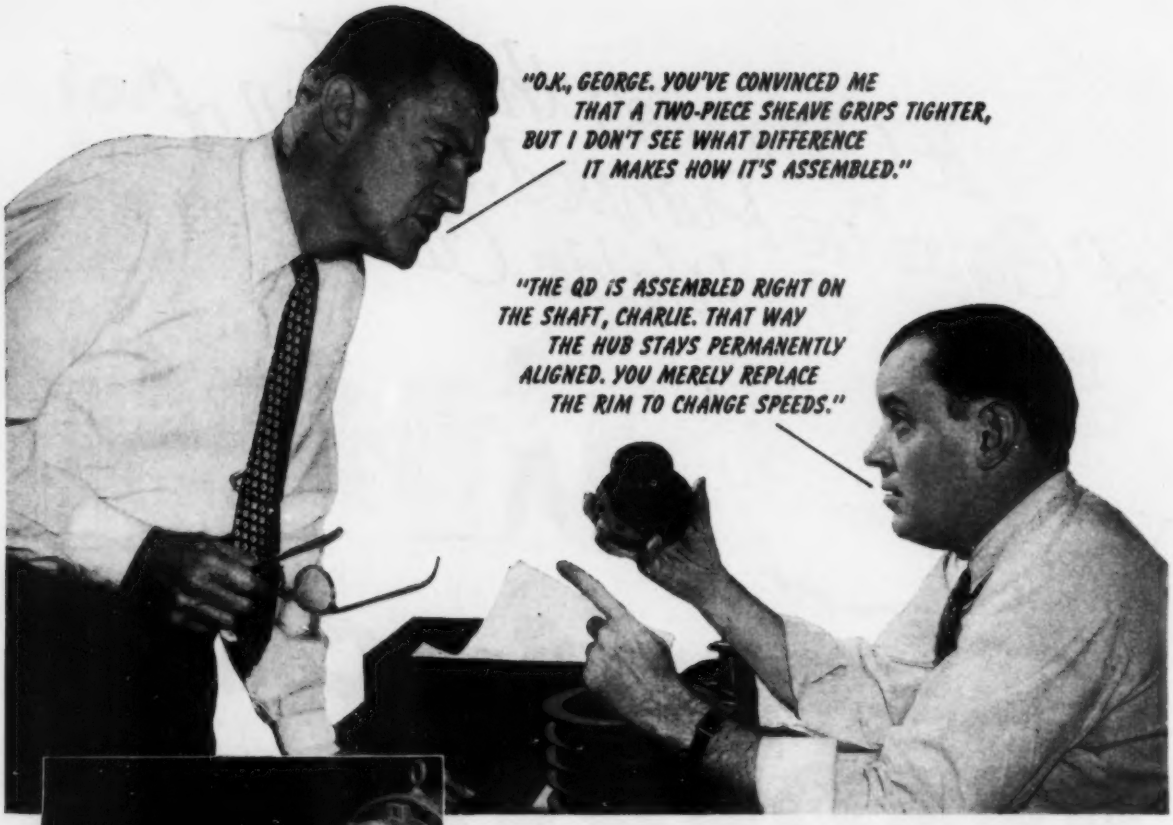
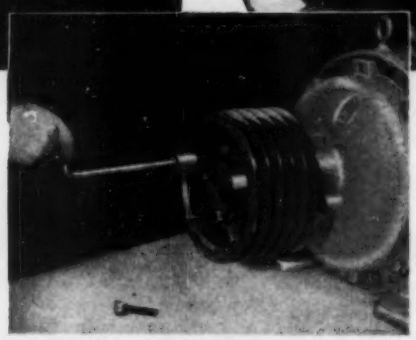
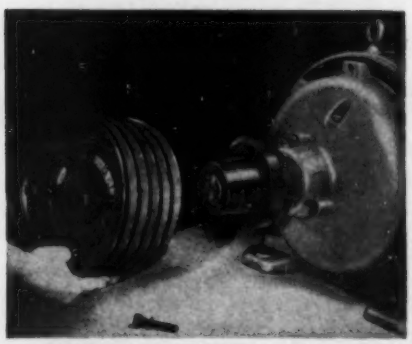

"O.K., GEORGE. YOU'VE CONVINCED ME THAT A TWO-PIECE SHEAVE GRIPS TIGHTER, BUT I DON'T SEE WHAT DIFFERENCE IT MAKES HOW IT'S ASSEMBLED."
"THE QD IS ASSEMBLED RIGHT ON THE SHAFT, CHARLIE. THAT WAY THE HUB STAYS PERMANENTLY ALIGNED. YOU MERELY REPLACE THE RIM TO CHANGE SPEEDS."



ONLY THE RIM COMES OFF. This is done by using the heavy assembly bolts as jack screws. Then the sheave slides easily off the tapered hub. No time-consuming prying or hammering is required.

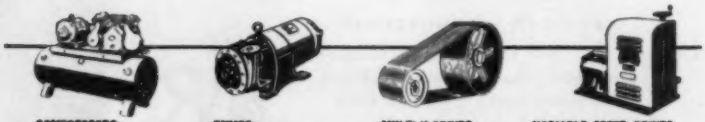


THE HUB STAYS PUT—there's no need to remove it when changing speeds. When you've finished the job, you just replace the rim over it and tighten the bolts. Alignment is *permanent*.

"How it's assembled" makes a big difference when you're choosing sheaves!

Because the famous Worthington QD can be assembled and disassembled right *on the shaft*, your maintenance man can change speeds merely by changing rims. The previously aligned hub need not be touched.

On initial assembly, holding alignment of the hub is a snap. All you do is tighten the flange cap screw after positioning the hub along the shaft. Drifting of the key is prevented by tightening the set screw over the key.



COMPRESSORS: AIR-COOLED, WATER-COOLED

PUMPS: CENTRIFUGAL, ROTARY, STEAM, POWER

MULTI-V-DRIVES: QD SHEAVES AND V-BELTS

VARIABLE SPEED DRIVES: WORTHINGTON ALLSPEED

You don't have to wait for Multi-V-Drive Equipment

WORTHINGTON-GOODYEAR EC CORD V-BELTS are the only belts available with a single parallel row of low-stretch, high tensile, heavy cord to withstand high flexing abuses required of short belts. Tire cord ply construction insures proper transverse rigidity on longer V-belt drives. Steel Cable V-belts and HY-T Super Rated V-belts will handle really tough drives. Prompt service on the complete line.

Worthington stocks a complete line of QD Sheaves, small V-pulleys, and Worthington-Goodyear EC Cord V-belts

Your local Worthington Multi-V-Drive distributor has a complete line of Worthington QD Sheaves, fractional horsepower V-pulleys and Worthington-Goodyear V-belts. He's backed by large factory stocks that enable him to fill your order *immediately*.

The Worthington fractional horsepower line of V-pulleys includes:

The QD Junior V-Pulley that will grip the shaft tighter than any other V-pulley now available. Its tapered hub is forced tight on the shaft and won't loosen due to shock or vibration.

Machined Steel V-Pulleys—3½ inches and under—precision-bored for proper fit. Grooves are accurately cut to provide proper seating of the belt for longer wear.

Pressed Steel V-Pulleys of heavy gauge welded steel. Equal weight distribution assures accurate balance and vibrationless operation.

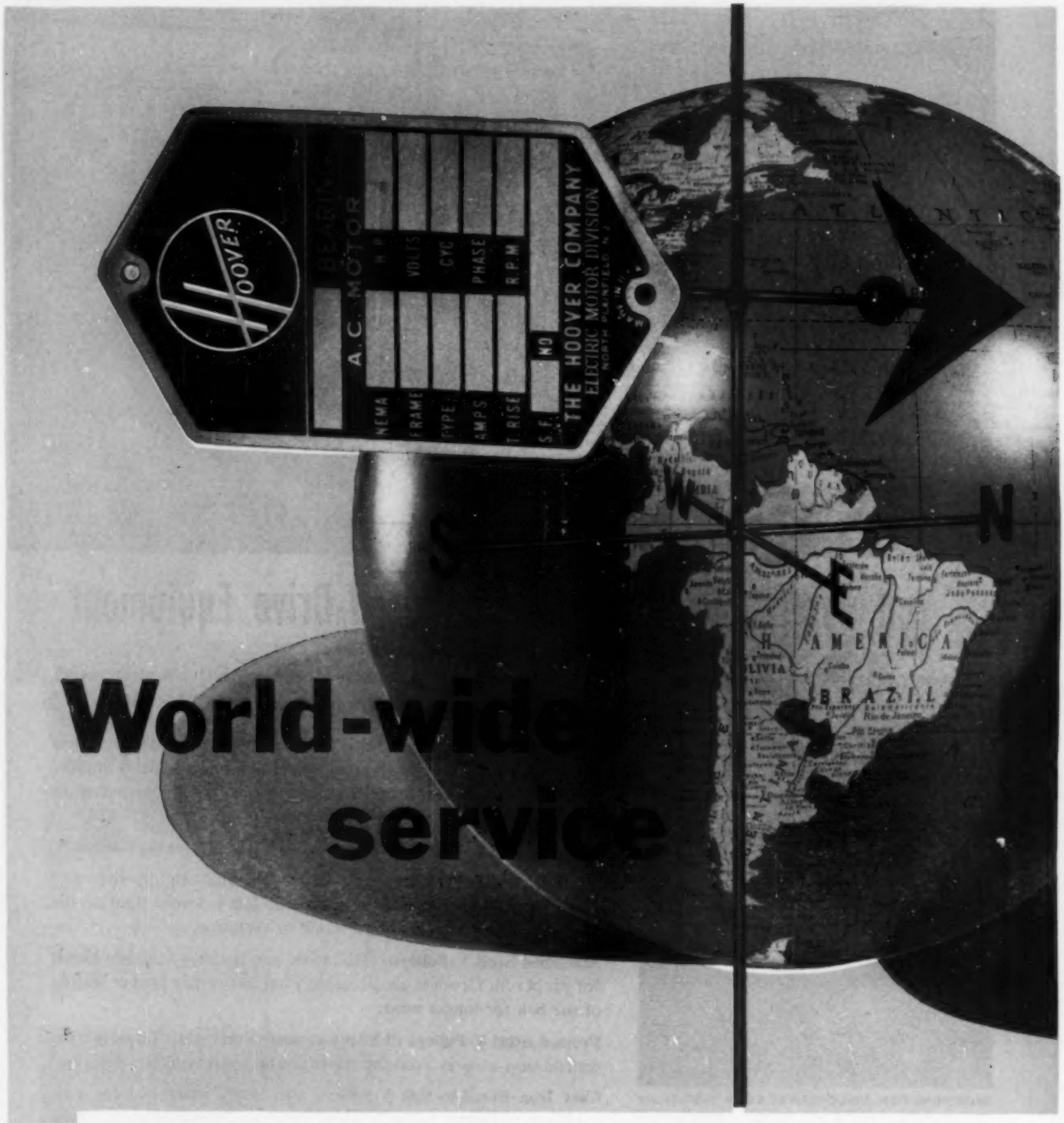
Cast Iron Bored-to-Suit V-pulleys accurately machined for true running and perfect balance. They come in a full range of sizes with one or two grooves.

For prompt deliveries, or further information on any Multi-V-Drive equipment, write to Worthington Corporation, Section MV.3.2, Oil City, Pennsylvania.

MV.3.2

Specify These Worthington Standard Products on Your Equipment

WORTHINGTON



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WHATEVER type of Hoover Motor you select, whether it is from the wide-range of "in-production" models or "custom-tailored" to your own specifications...

HOWEVER you may use that Hoover Motor, whether it's a standard application or a new or special one...

WHEREVER that Hoover Motor may go as part of the equipment you manufacture, whether it's Topeka, Toronto or Timbuctoo...

HOOVER'S WORLD-WIDE SERVICE will guard your good name... and ours!

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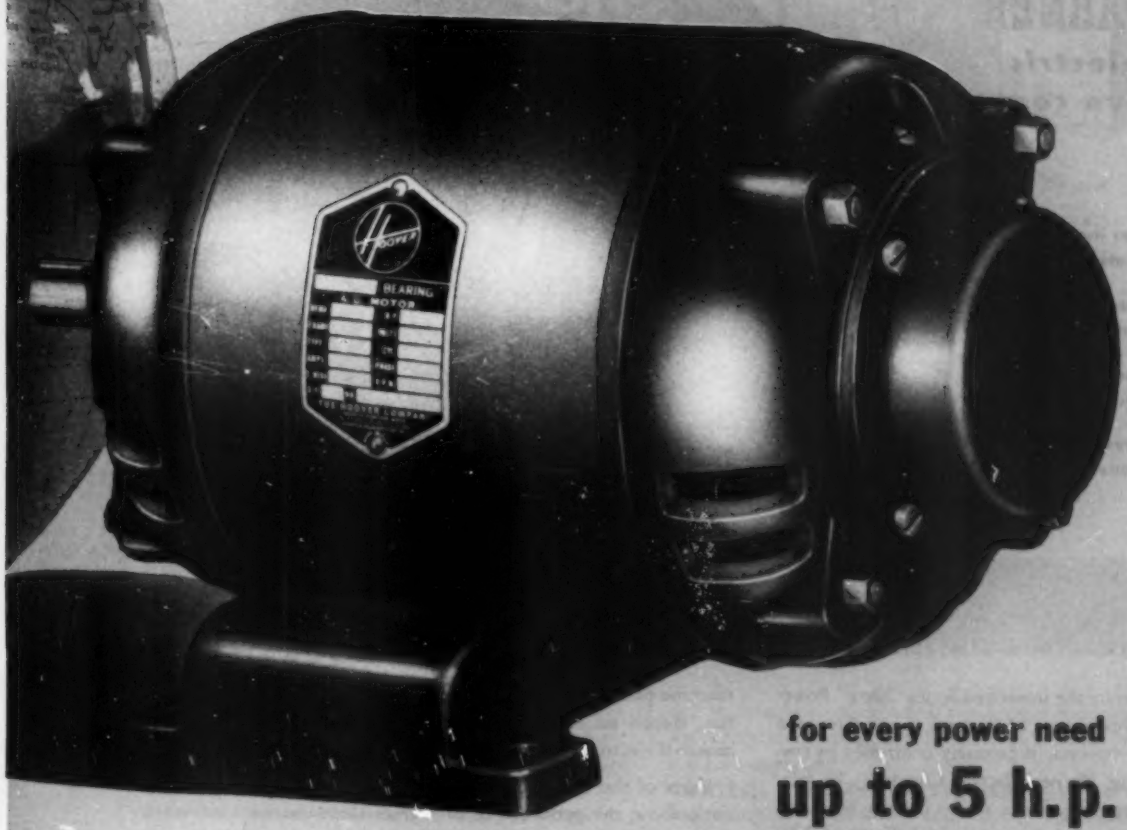
HOOVER

Heavy-Duty Electric Motors



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Week in and week out, Hoover is producing a very substantial volume of essential materials for the Armed Forces.

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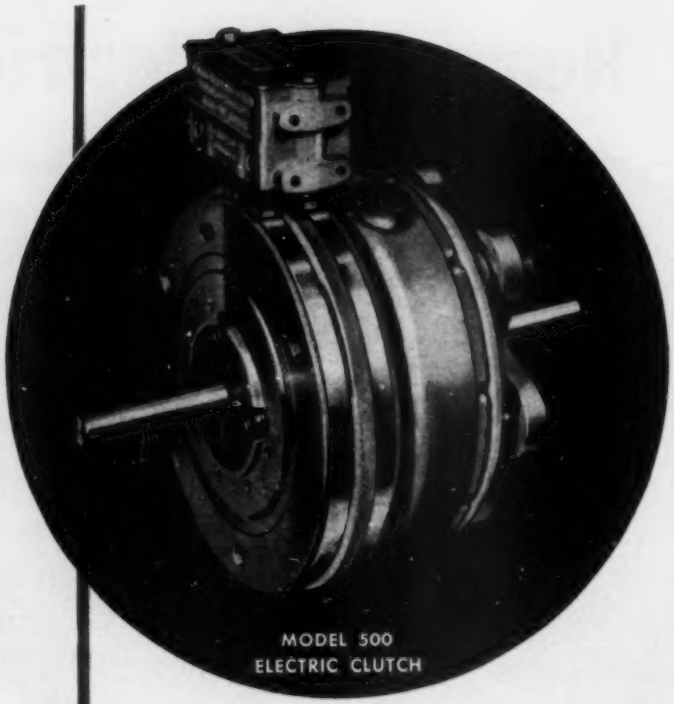
Precise control builds satisfied users of Seybold paper cutter with new Warner Electric Clutch

WARNER
electric
motion control

- **reduces maintenance—eliminates shock to machinery**
- **safeguards man and machine—accurate within .001"**
- **increases production—eliminates down-time**
- **replaces manual effort and skill—positions paper automatically**



MODEL 500
ELECTRIC CLUTCH

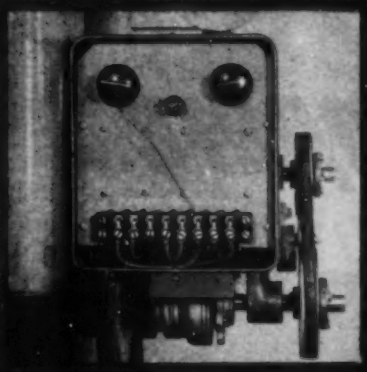
It's easy to operate the improved Series "Sixty" Power Paper Cutter. Movement of the back gauge through a *high speed* and *creep* cycle is precisely controlled by two instant-operating Warner Electric Clutches. In fact, stops are so precise—within .001"—the machine cuts faster, more accurately, with less manual effort and skill!

In replacing positive-tooth clutches, the Warner friction-type units not only improve performance greatly, they cut maintenance costs, eliminate down-time for servicing solenoids, and reduce wear and tear on other machine parts. While the clutch operation is lightning-fast, there's no shock or *clashing* from the smooth, *cushioned* electro-magnetic engagement.

Users of the improved Seybold "Sixty" are enthusiastic about the performance of Warner *electric motion control*. Perhaps your machine operations—involving speed control, braking, clutching, indexing, rapid cycling, tensioning, synchronizing, or coupling—may be similarly improved with only minor design changes. Your Warner Representative will show you how!

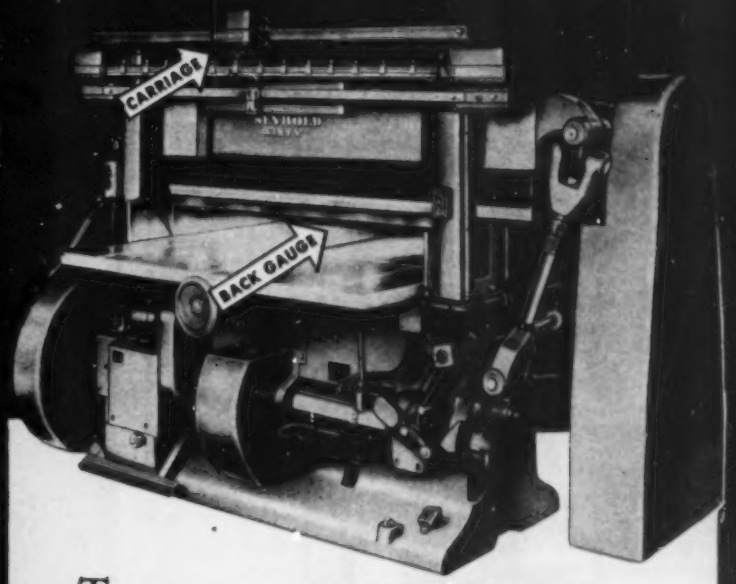
WARNER ELECTRIC BRAKES & CLUTCHES

FOR INDUSTRIAL APPLICATIONS



Warner Controller includes rheostats for adjusting torque and speed of each clutch, and relay for automatic switching from *high* to *creep* drive speeds.

Power from the main drive motor is transmitted through the Warner Electric Clutch, mounted on through-shaft, to lead screw driving the back gauge.



The Series "Sixty" Auto-Spacer, manufactured by the Harris-Seybold Co., Dayton, Ohio, cuts paper to exact lengths and widths. As the carriage travels along the spacer bar, it actuates the Warner Electric Clutch, engaging the back gauge *high speed* drive. When carriage contacts the stop dog, a second Warner Electric Clutch engages the *creep speed* before the paper is positioned for cutting. As the knife returns from the cut, the paper is automatically and precisely positioned for the next cutting cycle.

EQUIPPED WITH WARNER *electric motion control*

Warner Electric Brakes, Clutches and Clutch-Brakes give you new, unique simplicity of design and operation. There are only two main parts, an armature and magnet. Operation is by *electro-magnetic*, instantaneous engagement and release of friction surfaces. Torque ratings are extremely high for their small size and light weight. No coasting or slipping when "locked in." Easily designed into original equipment. Readily adapted to automatic cycles and remote control by limit switches, relays, electric eyes, pushbuttons, etc. Rate of application is accurately controlled to synchronize motions—give exact degree of speed and power required for your machine operation.

CONTROL ENGINEERING SERVICE . . . Warner offers complete application and control engineering service and field assistance. If you have a clutching, braking, tensioning, indexing, or speed-control problem, consult experienced Warner brake and clutch specialists for reliable recommendations on torque, heat, electrical controls, capacity, etc.

Warner Electric Brake & Clutch Co., Dept. MD, Beloit, Wis.

☐ Please send your FREE Booklet, WEB 6089.

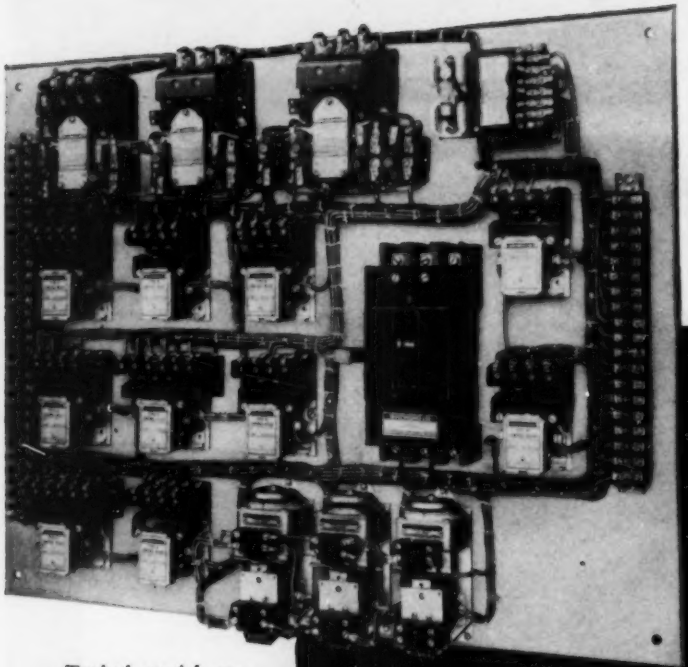
☐ Would like to see working demonstration.

Firm Name_____

Individual_____ Title_____

Address_____

City_____ State_____



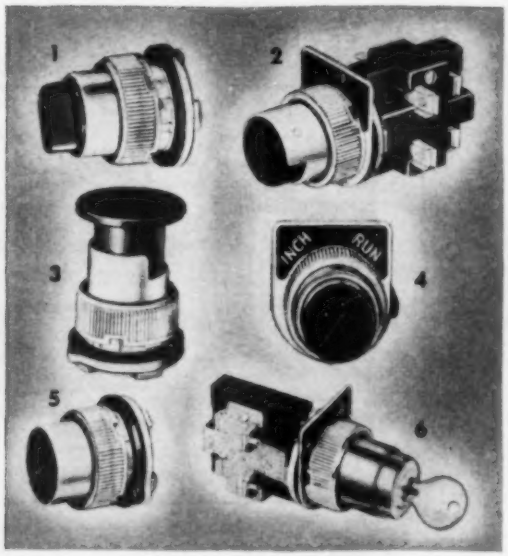
Typical special control panel with all Westinghouse components

Compare...

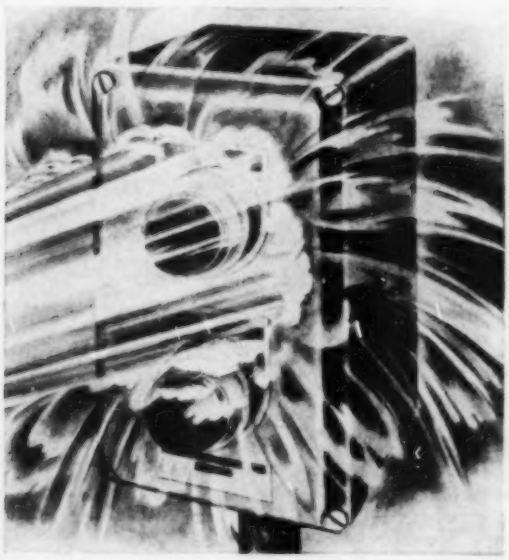
Westinghouse 6-Unit Oil-Tite Control Station

Compare the Westinghouse complete control line for any application

Westinghouse Oil-Tite* Control Stations



6 types of operating heads provide unit flexibility: 1. Selector Switch 2. Standard Head with Contact Block 3. Mushroom Head 4. Select-O-Push 5. Coin Slot 6. Key-Operated Cylinder Lock Pushbutton or Selector Switch



Westinghouse Controls have proved conclusively moisture tight. In this test, pushbutton stopped water stream 300 psi at 3 feet.

Interchangeable parts give maximum mounting flexibility, speed shipment, reduce inventory

The Westinghouse complete line of Oil-Tite Control Stations now offers even greater application flexibility. Engineered with interchangeable parts, a Control Station may be made up to solve every protection-from-oil problem. For applications particularly exposed to oil, coolants, cutting compounds, water and other foreign matter, Oil-Tite Heavy-Duty Control Units assure complete protection.

Standardization of parts spells faster shipment—smaller inventories. No need to wait weeks for "special orders". No need to carry large inventories of components when a limited number of Westinghouse standard parts will meet most requirements.

Here are the interchangeable elements in the Westinghouse Oil-Tite Line:

STATIONS are available in combinations of one to twelve units for surface, flush or panel mountings. Enclosures are die-cast—uniform in appearance. Cork-neoprene gasket assures positive cover seal.

CONTACT BLOCKS are box-mounted, eliminating wiring between box and cover. May be cover-mounted, too. Four types of blocks available.

OPERATORS are of six types. There are also eight contact sequence cams for the selector type operators. Accurately machined from castings of a special non-growing alloy. Supplied with color-fast plastic buttons (eight colors).

INDICATING LIGHTS are shock-resistant pyrex glass which will not change color—resist abrasion. Navy type lens in six colors. Visual identification from all angles.

Why not investigate the advantages of standardizing on Westinghouse for all your control needs—starters, contactors, relays, timers, transformers, terminal blocks, Oil-Tite Pushbuttons? Contact your Westinghouse Representative, or write for DB15-000, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-30155

*Trade-Mark

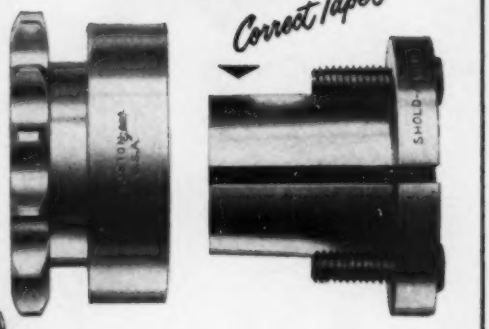
YOU CAN BE SURE...IF IT'S Westinghouse

New Buy-word for Top Value

SHOLD

FROM STOCK!

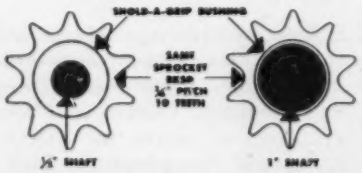
Correct Taper



Typical design (above) of SHOLD-A-GRIP Bushing and Sprocket with minimum number of teeth.
Typical design (below) of SHOLD-A-GRIP Bushing and Sprocket with maximum number of teeth.

FIT SHAFTS
½" to 2½" by 16ths

SHOLD-A-GRIP Sprockets of any commonly used pitch, ½" to 1¼", can be interchanged on an extended range of shaft sizes. SHOLD-A-GRIP design adds many smaller sprocket sizes to the interchangeable class.



Example: Sprocket BKSD, ¾" pitch, 10 teeth, can be used on 9 different shaft sizes, any size from ½" to 1" by 16ths, by inserting the correct size SHOLD-A-GRIP Bushing.

Engineered *originally* and *specifically* for Sprocket drives, SHOLD-A-GRIP Bushings are *not* an "adapted" design. Compare . . . see why SHOLD-A-GRIP means top efficiency, lowest maintenance costs.

GEARS • CHAIN and SPROCKETS • RATIOMOTORS • REDUCTORS • BOST-BRONZ Oil-Impregnated BEARINGS • PILLOW BLOCKS •

in Sprocket Assemblies . . . ask for

-A-GRIP®

Interchangeable Tapered BUSHINGS and SPROCKETS

You'll be Sure to get . . .

Correct Taper

FOR SLIP-PROOF GRIP

In SHOLD-A-GRIP Bushings and Sprockets, you get a taper proved by exhaustive overload tests to be the optimum for slip-proof grip. When screws are tightened the bushing grips both sprocket and shaft with maximum holding power, even on shafts which vary from true diameter.

Correct Taper

FOR EASY REMOVAL

Correct taper saves time and trouble in removal. Cap screws are removed, then two screws are turned into the two threaded holes in bushing flange. Tightening screws releases bushing—quickly, easily.

Matched Tapers

AVOID "ROCKING" FIT

All Bushing and Sprocket tapers are machined with integrated and matched tooling, to avoid possible variation from random production. There is no risk of a "rocking" fit. SHOLD-A-GRIP gives you fast, free interchangeability, over the entire size range.

High-strength Design

BY BOSTON Gear EXPERTS

Because of the unique, patented SHOLD-A-GRIP construction, holes for screws are in the shoulder. There are no weakening holes in the sprocket itself. BOSTON Gear quality throughout assures longer service life on your toughest drives.

Completely engineered and manufactured by BOSTON Gear . . . for 75 years the leading specialists in Stock Gear and Sprocket design.

Complete information on SHOLD-A-GRIP Bushings and Sprockets is available from your Boston *Gear* Distributor, or write Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

ASK YOUR NEARBY

BOSTON Gear® DISTRIBUTOR

UNIVERSAL JOINTS • COUPLINGS • BALL BEARINGS • OVER 5000 STOCK ITEMS

You wouldn't specify
Chrome-Moly for
roofing nails

Why pay for unneeded "specs" in ball bearings?

In many applications where speeds and loads are moderate, you don't need a precision bearing. When this is the case, Schatz "Commercial" Ball Bearings can cut your costs by as much as 85%—*without any sacrifice in operating efficiency.*

Why are savings like this possible? Because "Commercial" Ball Bearings are designed to wider tolerances than precision bearings...because they are available unground, partially-ground, or fully-ground. And, because, in almost all cases, cages are not used.

If you have an application where speeds and loads are moderate, it will pay you to look into Schatz "Commercial" Ball Bearings. To learn how you may save, write for literature described below.

THE SCHATZ MANUFACTURING COMPANY
6758 Fairview Avenue, Poughkeepsie, New York

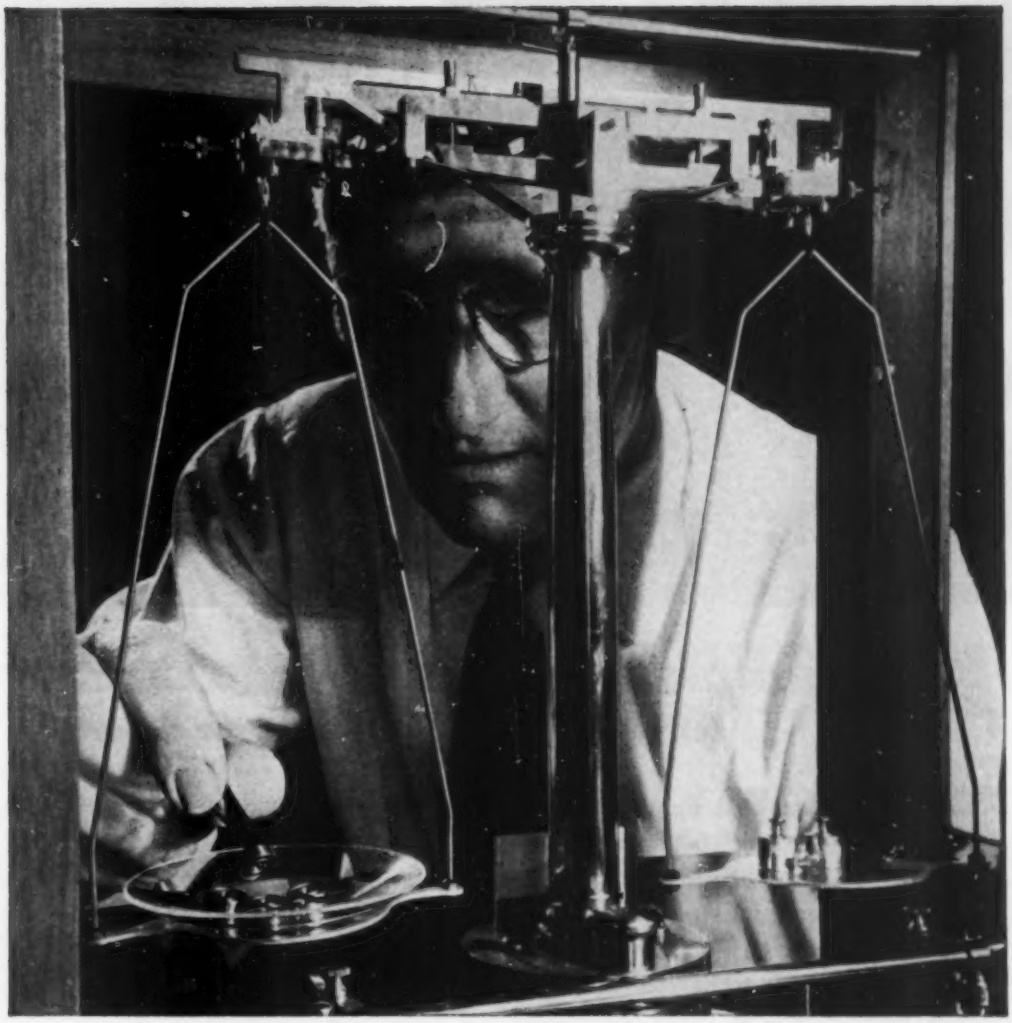
Schatz "Commercial" Bearings used on these products

Dishwashers • Outboard motors
Automobile steering mechanisms
Elevators • Box machinery
Office equipment
Flexible shafts • Lawn mowers
Masonry cutting equipment
Textile machinery • Farm equipment
Laundry equipment
What about your product?

The oldest, largest manufacturer of "Commercial" ball bearings

SCHATZ
"Commercial"
BALL BEARINGS

Technical literature available:
Schatz Catalog 11 contains drawings and specifications of Schatz Ball Bearings.
Technical Bulletin tells how to determine proper type and size "Commercial" Ball Bearing for various speeds and loads.
Nylon Bearing Parts discusses advantages of nylon parts in "Commercial" bearings.



How much grease will a bearing keep?

IT ALL DEPENDS upon the application, of course, but grease-retaining properties can be extremely important in the operation of ball bearings. Automobile clutch bearings, for example, must not throw grease: if they did, grease would get on the clutch, causing it to slip and chatter.

Federal technicians weigh the specified Federal Ball Bearing, run it under actual operating conditions, then re-weigh the bearing on a precision balance to determine the amount of grease lost. In the case of automobile clutch bearings, grease loss cannot exceed *four grams!*

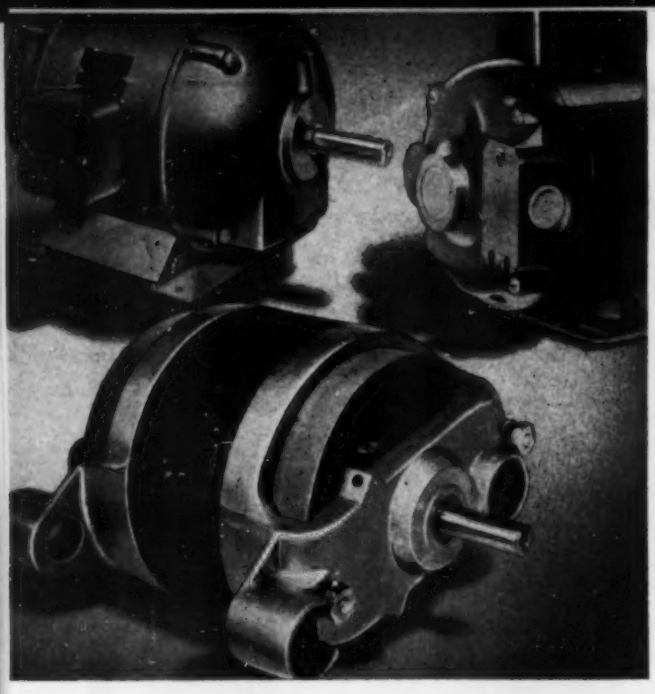
Of course, this is only one of the many tests used to prove Federal Ball Bearings—and only one of the many reasons you can be sure of top-notch performance from *every* Federal Ball Bearing.

The Federal Bearings Co., Inc., Poughkeepsie, N. Y.

Federal

Ball Bearings

One of America's Leading Ball Bearing Manufacturers



Complete Motors... or Motor Parts

Let your design problem make the choice!

Standard motors and matched motor parts represent only the beginning of what R & M is qualified to build! Special R & M fractional-horsepower with *any* housing design—or specially designed motor parts to fit your housings—are regular R & M contributions to products such as those listed at right:

Portable Saws	Vacuum Cleaners	Portable Grinders
Drills	Files	Sirens
Nut Setters	Sanders	Hair Driers
Hammers	Pumps	Advertising Devices
Routers	Compressors	Ventilating Equipment
Screw Drivers	Hones	Oil Burners
Hedge Trimmers	Business Machines	Surgical Instruments
Lawn Mowers	Cast Cutters	Grease Guns
Nibblers	Food Mixers	Vibrators
Lock Mortisers	Polishers	Die Sinkers
Valve Grinders	Planers	Waxers

The machine that tests motor performance . . . in minutes instead of months!

Formerly it took months to do a really thorough job of calculating motor performance and requirements for a given job. Now, using the unique R & M "Electrical Slide Rule," the performance of any one motor design can be calculated in about 20 minutes! Result? R & M can engineer a motor to your exact requirements . . . thoroughly, accurately, *and in time to meet your production and marketing schedules!*

You can expect quality . . . from every Robbins & Myers motor!

Here, for example, are some of the quality features built into R & M universal motor parts:

1. Every field coil has paper in the slots—in addition to standard taping. More insulation means longer motor life, fewer failures.
2. Insulating material is selected for the job. For example, glass insulated wires are used in sander and saw motors.
3. R & M motors are varnish-dipped and baked—as much as *three times* when service requires it.
4. Standardized commutators and laminations—for mass-production at no sacrifice in quality.
5. Diamond-turned commutators . . . for greater concentricity and smoother surface finish. Brushes last longer!
6. Matched Motor Parts are precision-built, 100%-tested, dynamically balanced, fully interchangeable.

How to select the best Fractional Horsepower Motors } FOR MACHINES, POWER TOOLS, APPLIANCES

The most important single factor in motor performance is *selection* of the right motor for the job. That's why R & M offers such a wide variety of types and sizes of motors and motor parts. From these many standard and special-standard types we can, in most cases, help you select the motor to help give your product the best all-around performance.

We Also Custom-Design, Economically!

Your problem may require a custom-designed motor. If so, we'd much rather work out a special motor for you than see you take an "off-the-shelf" compromise.

Ordinarily the extensive calculations required make custom-designing pretty expensive. We've licked that problem, too, with the unique R & M "Electrical Slide Rule." This is an electrical motor-performance calculator. With it, the designer can reduce the work of a whole day or two to about twenty minutes! Naturally you and we both benefit.

Some Other Advantages of R&M Motors

R & M offers some special construction features: extra insulation; glass insulation where heat requires it; diamond-turned commutators; extra varnish treatment; a gratifyingly low failure rate.

As a pioneer in the small motor field, we have designed and built millions of small motors for thousands of different applications. And so we naturally feel well qualified, with engineering skill and experience, and extensive manufacturing facilities, to do an exceptionally good job for you. At least, it won't cost you anything to find out.

Let Us Tell You More

Call the nearest branch office for an R & M Motor Specialist—or write us for the information in which you are interested. Use the check list below.

ROBBINS & MYERS, INC., MOTOR DIVISION,
Springfield 99, Ohio:

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ Universal and DC Motors
- ☐ R & M "All-Weather" Motors—up to 125 HP
- ☐ Please have a Motor Specialist call

*Product we manufacture:*_____

*Name*_____ *Title*_____

*Company*_____

*Street*_____

*City & State*_____

R&M MAKES BOTH!
Fractional horsepower motors and parts ... from 1/200 h.p.

If it's an R&M, it's the Right Motor!

Integral Horsepower motors; famous R&M "All-Weather"* motor with sealed bearings. Up to 125 h.p.

*"*All-Weather*" *is an R&M trademark*

ROBBINS & MYERS, INC.

SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

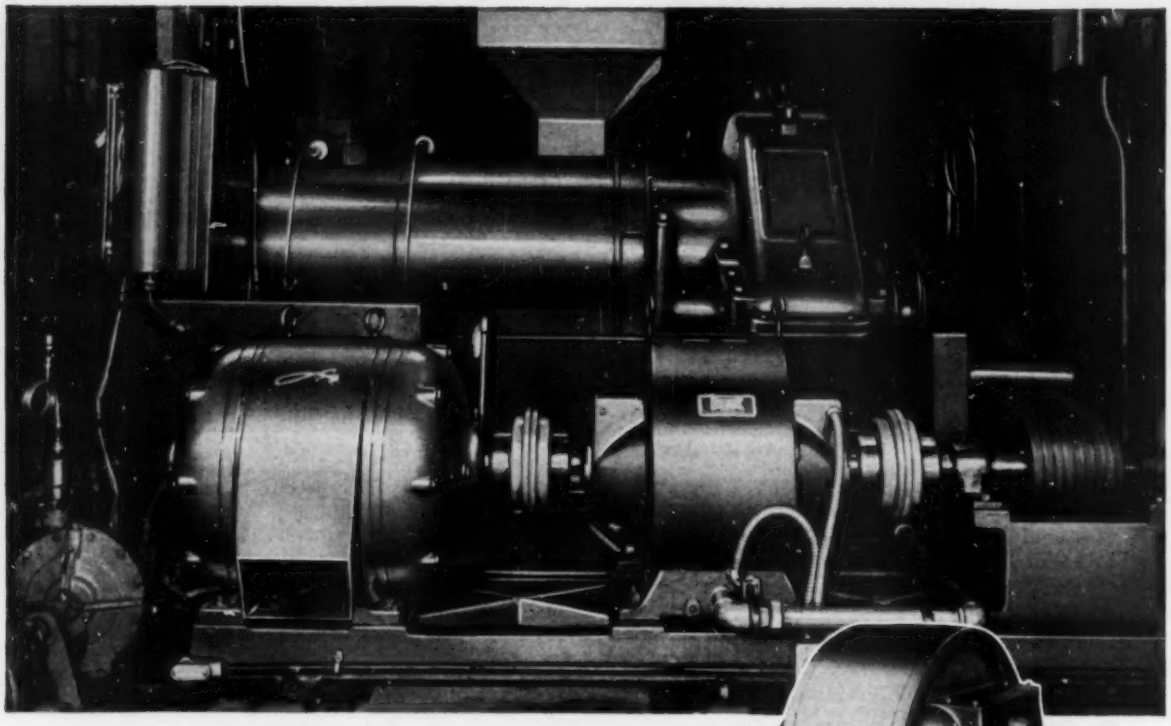
Fractional & Integral h.p. Motors & Generators

Electric Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment



Model 6-W Dynamatic Water-Cooled Coupling, driving a No. 8 National wire jacketing extruder from a 100 HP, 1800 RPM cage motor in the plant of a large electrical manufacturing company.

DYNAMATIC®

WATER-COOLED POWER COUPLINGS

Adjustable Speed Drive from AC Source

WIDE SPEED RANGE

INSTANTANEOUS RESPONSE

ACCURATE SPEED CONTROL

STEPLESS SPEED ADJUSTMENT

SMOOTH TORQUE TRANSMISSION

TOTALLY ENCLOSED

SIMPLE • QUIET

COMPACT • EFFICIENT

Dynamatic Water-Cooled Couplings provide adjustable speed drive direct from an AC power source for a wide range of industrial applications. They transmit rotation from a driving to a driven member without mechanical contact, with stepless adjustable control and almost instantaneous response. A simple method of providing adjustable speed from a constant speed source (or vice-versa) with full torque starts.

Effective water-in-the-gap cooling permits large capacity in small space; design provides complete protection against atmospheric impurities.

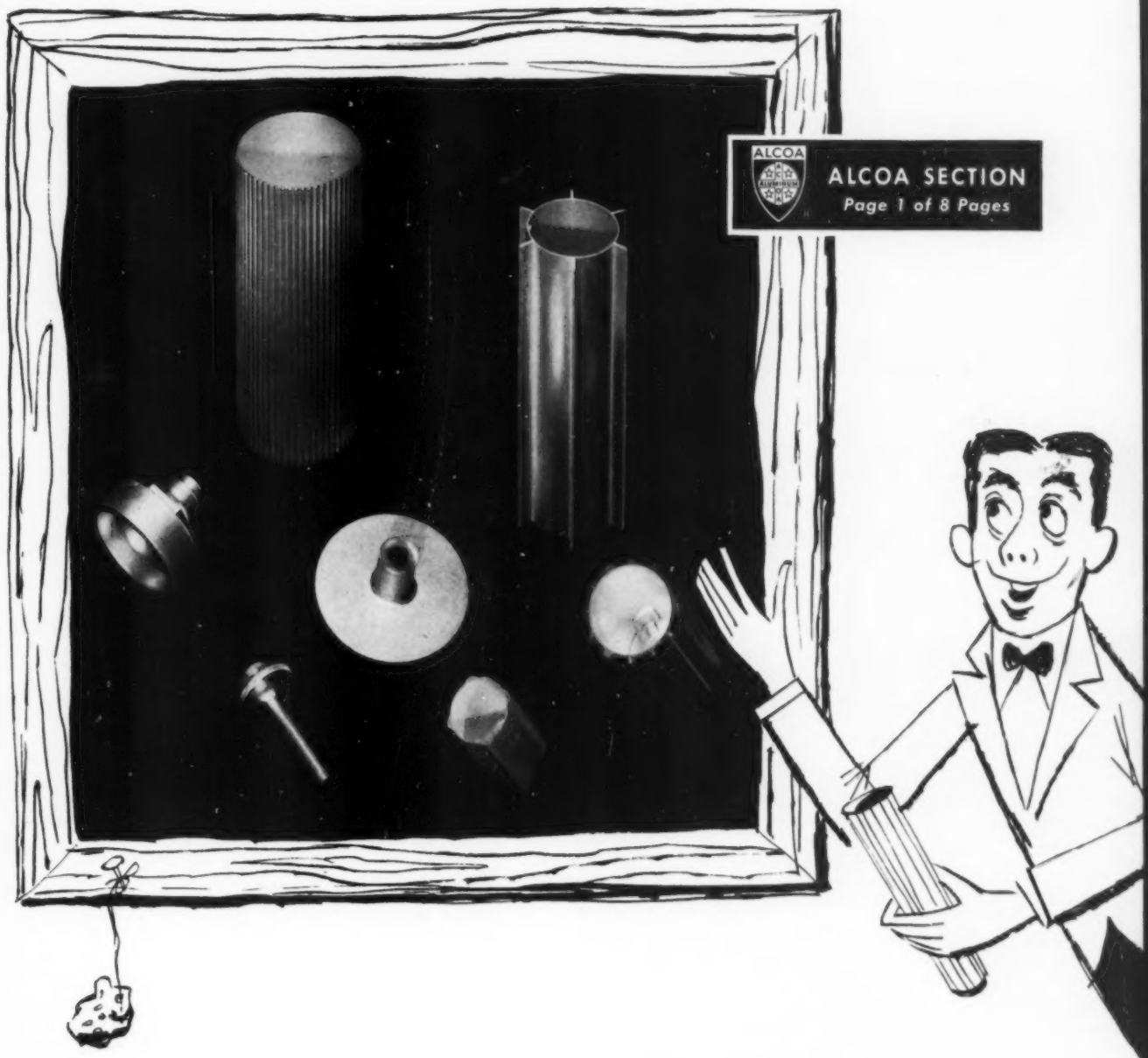
Standard sizes are available for transmitting torques of 50 pounds feet to approximately 5,000 pounds feet. Units up to 200,000 pounds feet or larger can be built to order.

Write for Illustrated Booklet WC-1

DYNAMATIC® **CORPORATION** • **KENOSHA WISCONSIN**

Subsidiary of **EATON MANUFACTURING COMPANY,** **Cleveland, Ohio**

Dynamometers • Oil Well Draw-Works Brakes • Adjustable-Speed Couplings • Eddy-Current Brakes
Ajusto-Spedes • Shovel Clutches • Press Drives • Lift Truck Clutches • Electronic Controls



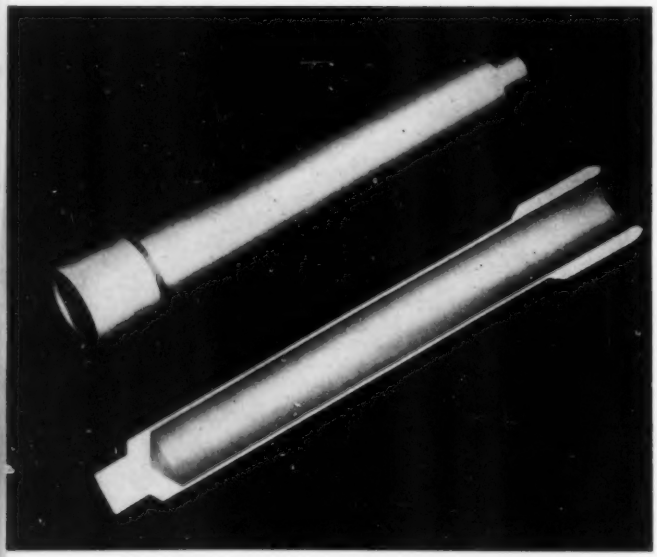
With a background of over 30 years in the production of aluminum impact extrusions, Alcoa is now utilizing the full capabilities of this process to produce still more complex parts—faster—cheaper. Basically, impact extrusion is a simple operation, the combination of cold forging and conventional extrusion. A slug is placed in a die, a punch rams down onto the slug, and the metal, its flow guided by the shape of the die, is forced, in a split second, up and around the punch. The die forms the outer contour of the finished part, the punch, the inner contour. Practically any round, square, rectangular, oblong, cup, or shell-shaped piece with beaded or fluted side walls, or with bosses, recesses, or projections can be made by this process.

New alloys and press techniques enable impact extrusions to compete with castings, drawings, forgings, screw machine products, and weldments. As the world's largest producer of aluminum impact extrusions, we feel qualified to tell you . . .

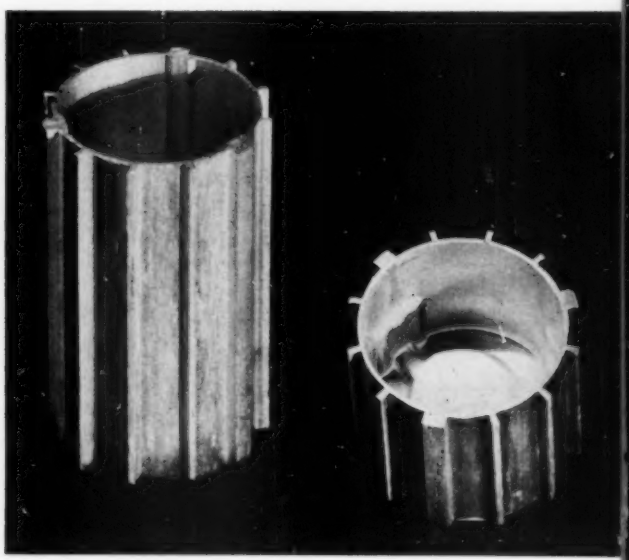
What tomorrow's design supervisors should know about Aluminum Impact Extrusions today...

Who uses Impact Extrusions?

Industry figures show that as recently as 1946, 95 per cent of all the metal going into the impact extrusion process was used to make collapsible tubes. But today it is being used to produce everything from collapsible tubes to delicate housings for medical instruments on up to heavy-duty parts for aircraft. Here, for example, are some notable examples of products now being made by this process . . .

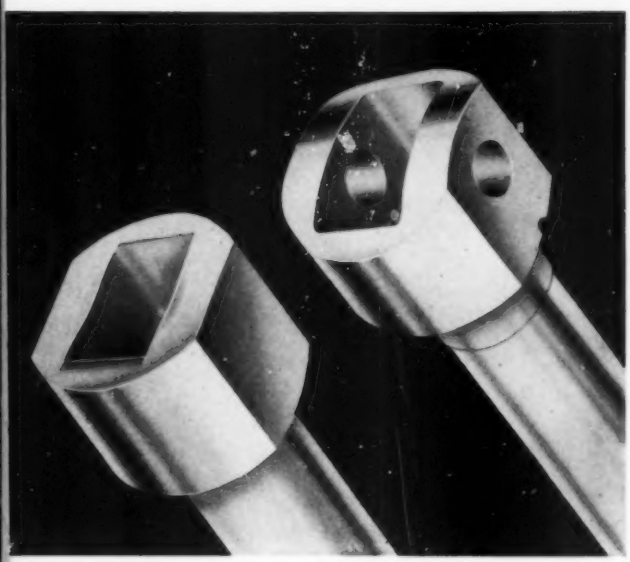


HYDRAULIC PLUNGERS. Used as plungers in hydraulically operated landing gear for jet aircraft, these are particularly good examples of recent developments in the impact extrusion process. High strength called for 14S-T6 alloy. Formerly hogged out of bar stock, savings as a result of using impact extrusions were measured in lower costs as well as in conservation of strategic bar stock.

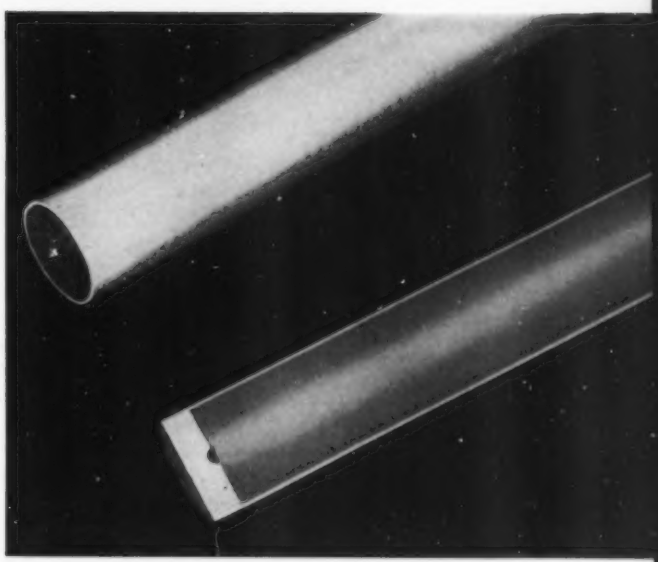


MOTOR HOUSING. Used to house the motor for an electronic cooling fan, this part would be difficult to produce by any other method except expensive forming and assembly operations. Ribs serve a dual purpose—as spacers for an outside shroud and to add greater surface for improved heat radiation. Alloy 2S-F was used since strength was not an important factor.

". . . everything from collapsible tubes . . . to heavy-duty parts for aircraft."



DIESEL INJECTOR PART. Good example of semisolid impact extrusion emphasizing material economy and elimination of costly machining. Topping the solid stem is an odd-shaped head into which a depression of special contour has been placed. Parts similar to this unusual design can often be produced on the same presses used to produce more conventional impact shapes.



CAN. Rule of thumb for determining length-diameter proportions is about 8 to 1. But this part, used by the government, demonstrates what latitude can be expected from the extrusion process providing proper care is taken in design and production. Note clean surfaces, free of draft, thick base relative to side walls.

ABOUT COSTS

If your product lends itself to impact extrusion, it can probably be produced faster, in greater quantities and at less cost by this method than by any other. For example, if you want to produce a simple shell or cup-shaped article, the slug for the part would probably be in the press for about one second. Twenty per cent of that time would be used to form the part, the rest for loading and ejecting. It's that fast. It means lower costs, faster production, greater quantities.

Tool and die costs are low, almost always lower than for any other process you could consider. Impact production eliminates costly multiple-shaping operations and assembly. Close tolerances on Alcoa® Impacts are strictly maintained. Hence, less machining, low scrap loss.

"... it can probably be produced faster, in greater quantities."

ABOUT PHYSICAL PROPERTIES

You've probably guessed that impact extrusions are light and easy to handle in production. They also possess the characteristics of forged metal—dense, nonporous. Impacts made of high-strength alloys such as 75S offer a tensile strength of 75,000 psi and a yield strength of 65,000 psi. Often, they require no machining. When they do, it's usually limited to simple operations such as drilling and tapping. Surfaces are clean with smoothness ranging between 40 and 250 micro-inches, depending on variables existing during extrusion and the requirements of the job.

Thick bases, thin side walls free of draft are outstanding characteristics of Alcoa Impacts, and they are available with close dimensional tolerances. Alcoa Impacts have only slight piece-to-piece variations.

Whatever the requirements of your product, there is an Alcoa Alloy to fulfill them. 2S and 3S are probably the easiest to mass produce. For most high-strength parts, 61S is probably the most suitable. If extreme high strength is needed, 14S or 75S alloy should be specified.

IMPACT EXTRUSION VS. DRAWING

Tooling for impacts costs less than for drawings, especially where shell length requires several draws. When shell length is the only consideration, designers usually follow the rule that for any shell greater than 1½ to 2 times the diameter, impact extrusion should be used. Also, when the base must be thicker than the side walls or when it must contain bosses, lugs, projections, or recesses, only the impact process can be used.

IMPACT EXTRUSION VS. FORGING

Yield and tensile strengths of impact extrusions are comparable to those of forgings. An impact extrusion made of 75S alloy has strength characteristics comparable to 1020 steel, combining strength with lightness.

Alcoa Impacts are invariably lighter than their forged counterparts, have superior surface characteristics, closer dimensional tolerances and require no draft angle.

IMPACT EXTRUSION VS. MACHINING

On production runs, similar products can be turned out many times faster by impact extrusion than by screw machine or turret lathe. Here, again, there's greater metal yield, less scrap loss, with most scrap recoverable and re-usable right in the extrusion plant.

IMPACT EXTRUSION VS. CASTING

A part produced by impact extrusion would invariably be lighter than if cast—less metal, equal strength—thus raising the strength-weight ratio. True, at this stage of impact extrusion development there are not many parts that could be made by both processes. However, where the design is within the limits of the process and where superior properties are required, the use of impact extrusions should be considered. Surfaces are cleaner, less machining is needed, there's more metal yield, less scrap loss.

IMPACT EXTRUSION VS. WELDMENT

One-piece construction of impact extrusions makes them more economical to produce than the same product fabricated by welding. Rate of production is higher, labor costs lower. Furthermore, the possibility of seam failure does not exist.

What's in the future for Alcoa Impacts?

Although few other fabricating processes can produce parts with closer tolerances, results of present-day Alcoa research indicate that tomorrow, Alcoa Impacts with even greater dimensional fidelity will be produced more consistently, faster, at lower costs. New techniques are being perfected, such as lateral extrusion, where parts having a central hub section with arms or spokes of various cross-sectional shapes can be produced.

Today it is common practice to produce parts made by a combination of forward and reverse impact extrusion in one operation. Tomorrow lateral extrusion will be commonly used. It could conceivably be used in conjunction with the more orthodox forward and reverse processes to turn out impacts far more complex than any yet on the drafting board.

What's more, the process is expected to be further refined to the point where high-speed production of complex parts made from high-strength alloys will be commonplace. In short, Alcoa's development work on the impact extrusion process promises to widen its use as a fabricating method totally capable of producing, on one hand, more precise and, on the other hand, more tough and certainly more complex impacts—all at lower cost.

". . . look for impacts far more complex than any yet on the drafting board."

What Should You Know About Designing for Alcoa Impacts Today?

Designers once felt all parts produced by impact extrusion process should have balanced, symmetrical cross sections. But today, at Alcoa, it is not unusual to see parts with unsymmetrical cross sections in production.

Alcoa Impacts with their forged bases and extruded side walls have wrought metal characteristics. If your product requires such properties, take a close look at impact extrusion.

The most important point, however, that designers should keep in mind is that while impacts can be produced from high-strength alloys such as 14S and 75S, it is best not to specify their use unless product application specifically calls for the high strengths these alloys offer. As side walls get thinner and alloys stronger, forming pressure must necessarily be increased. This means lower production speeds, higher per-piece costs. Should high strength be needed, however, and if your product suits the process, it would probably still be more economical for you to utilize the impact extrusion method in favor of any other.

On reverse extrusions, maximum length is related to the slenderness ratio of the punch and should not exceed 6-8 times the punch diameter for the higher-strength alloys. Generally, if these values are exceeded, the punch has a tendency to wander, causing wall thickness variation. On forward extrusion, parts can be made to lengths many times the diameter, provided there is sufficient space into which the extrusion can flow and if the stroke is long enough to allow the part to be ejected from the die. When the inside diameter of an impact is greater than three inches, it's best to use a taper at the bottom to facilitate metal flow and to decrease punch wander.

Alcoa Impacts can be finished in a wide variety of attractive as well as functional finishes. They can be dipped, polished, satin finished, enameled, lithographed, lacquered, or given the special Alumilite* finish which provides a much harder oxide protective surface than that which naturally forms on aluminum. The smooth surface, characteristic of all impact extrusions, regardless of alloy used, takes all these finishes well.

*Trade Name of Aluminum Company of America.

In this small space, it would be virtually impossible to cover all phases of the impact extrusion process or illustrate all the possible uses to which it can be put.

Should you have further questions, write on your company letterhead to ALUMINUM COMPANY OF AMERICA, 1992-H Alcoa Building, Pittsburgh 19, Pennsylvania, for your free copy of Alcoa's book, *Alcoa Aluminum Impact Extrusions.*

Better still, contact your local Alcoa sales engineer. He's listed under "Aluminum" in the classified section of your telephone book. Whether you plan to buy aluminum impact extrusions tomorrow, next week, or a year from now, he'll be glad to discuss your production problem with you. That's his job.

Saved! **thousands of man-hours...thousands of bearings... thousands of dollars!**

ALEMITE OIL-MIST

the most efficient machine lubrication ever devised!

1 MULTIPLIES Bearing Life!

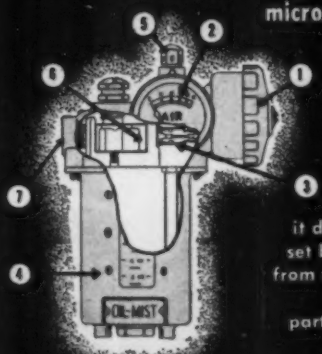
2 SLASHES Product Spoilage!

3 BOOSTS Machine Output!

It's almost unbelievable, but the record proves it's true! Oil-Mist has literally saved thousands and thousands of dollars. Even more important is the equally impressive record of increased production. Increases impossible without this completely new conception of lubrication. This increased production, increased bearing life and decreased product spoilage has paid for installation after installation in a matter of weeks.

This is a completely new, amazingly simple, system of lubrication. Easy to incorporate into new projects, just as easy to use in modifying existing designs. Oil-Mist applies a constant, clean, cool film of oil uniformly to working parts—groups of bearings, slides, chains, gears—wherever needed. And in the form needed—liquid, spray or mist. The lubricator has no moving parts . . . operates on compressed air, is completely automatic, completely foolproof!

HOW IT WORKS: The Oil-Mist Lubricator atomizes oil into microscopic particles which are carried in the air stream and distributed through tubing to bearings.



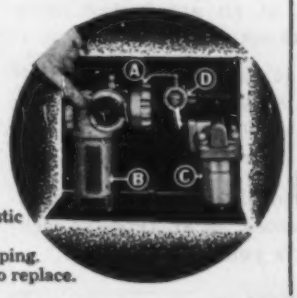
Oil-Mist airborne lubrication is accomplished this way: Compressed air entering the unit passes through air regulator (1) and air gauge (2). As this air passes through venturi (3) it draws oil from reservoir (4). Oil flow is set by knob (5). The mixture of air and oil from the venturi is thrust against baffle (6). Only the most minute, lighter-than-air particles are blown through outlet (7) into delivery line to lubricate bearings.

Alemite Oil-Mist offers these lubrication advantages

Automatic Lubrication • Continuous Lubrication • Eliminates Guesswork • Greater Safety Cuts Oil Consumption up to 90% • Extension of Bearing Life • Stops Oil Drippage Reduction of Bearing Temperatures • Manpower Savings • Elimination of "Down-Time" Reduction in Number of Lubricants • Protection from Contamination

LUBRICATOR SPECIFICATIONS:

- Oil-Mist outlet ½" fem. p.t. Air gauge registers to 50 psi. Operating air pressure – 5 to 20 psi.
- Air regulator (A) reduces from pressures up to 200 psi. Normal air consumption –.7 to 1.2 cfm.
- Range of oils handled – to 1,000 sec. (S.U.V.) @ 100°F.
- Oil reservoir (B) capacity 12 oz. (approximately 1 week supply). Intake filter screen – 70 mesh. Fill plug – 9/16".
- Material – die cast aluminum body with nylon plastic window.
- Baffle-type water separator (C) –automatic self-dumping. Requires no manual attention – no filter elements to replace. Air inlet ¼" fem. p.t.
- Solenoid Control (D) starts system automatically when machine starts – foolproof.



delivers oil to bearings 3 ways!

1. Oil-Mist as Such. Most commonly applied to any type of anti-friction bearing – ball, roller or needle.

2. Oil in Spray Form. For open and enclosed gears and chains. Nozzle partially condenses mist so that it can be directed on to a concentrated area.

3. Oil-Mist Condensed. For plain bearings, slides, ways, vees, cams and rollers. In these applications, condensing fittings convert oil-mist to liquid oil.

Alemite OIL-MIST Lubrication

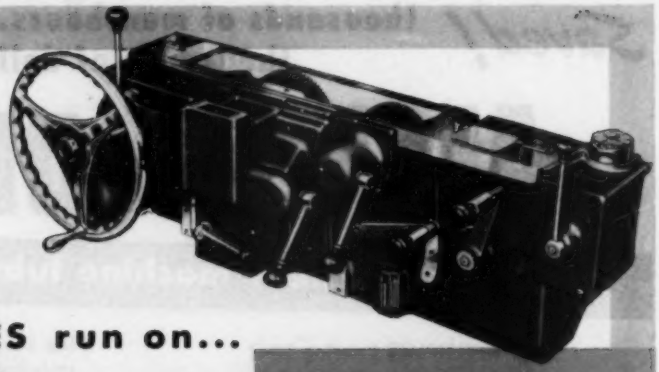
SW

Write Today! **This Oil-Mist Catalog and Engineering Data Book is FREE for the asking. Write now for your copy. Alemite, Dept. T-83, 1850 Diversey Parkway, Chicago 14, Illinois.**

Feed Pinions in Aprons of 25" and 32"

AMERICAN

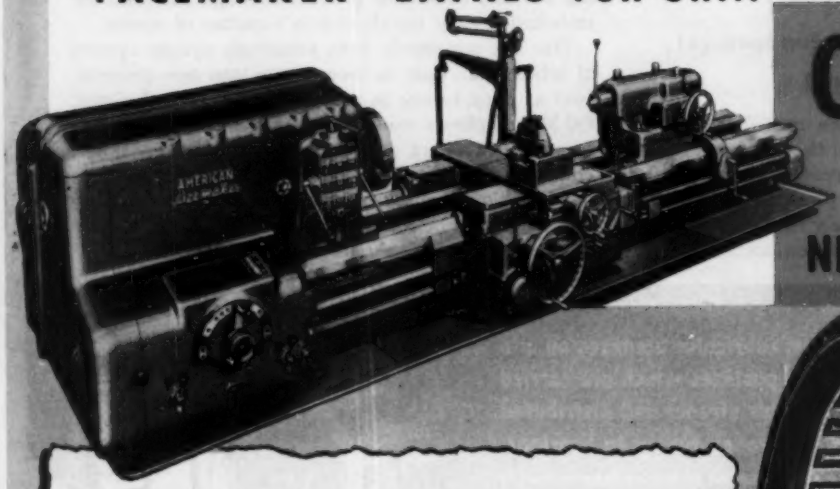
"PACEMAKER" LATHES run on...



ORANGE

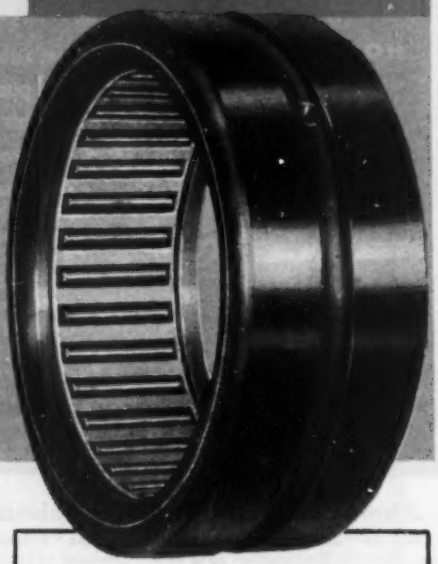
Cage Type

NEEDLE BEARINGS



"They are dependable, long-lived and the cage design insures perfect alignment of rollers".

— reports American Tool Works Company



Orange Cage Design prevents roller skewing

In Orange Cage Type Needle Bearings, the rollers are held in alignment by retaining pockets of an anti-friction, non-ferrous cage. The cage guides, but does not wear on rollers.

With roller skewing eliminated, Orange Cage Type Needle Bearings permit you to gain the high load capacity and space savings of needle bearings on many applications heretofore unsuited to conventional types.

The Orange cage design is time-proven—has been used successfully for years on numerous installations, in all types of well-known equipment. Investigate them for your own products.

Send for Engineering Data Book

TRUE RUNNING IN ANY POSITION

—vertical, tilted, horizontal
—on overhung mountings
—at relatively high speeds

•

Less affected by misaligned mountings or uneven loading

ORANGE

ORANGE ROLLER BEARING CO., INC., 551 Main Street, Orange, N. J.

G-E cord helps today's appliances do a better job

General Electric rubber-jacketed cords, designed for today's appliances, are built to take day-to-day abuse. One example is G-E Type SV cord . . . a lightweight, flexible cord particularly designed for use on vacuum cleaners, food mixers, office machines, and similar light-duty equipment. The complete line of G-E Types S, SO, and SV cords will provide you with a dependable, flexible cord for practically any type of light-, medium-, or heavy-duty electrical appliance or industrial equipment. G-E cords are available in several types of conductors and in a wide variety of wire sizes.

On your assembly line

The tinned-copper conductors of most sizes and types facilitate connections and reduce assembly cost by eliminating the necessity for a cotton separator. The rubber insulation strips cleanly. You'll get economical assembly when you equip your products with G-E rubber-jacketed cords. For more information, write Section W60-867, Construction Materials Division, General Electric Company, Bridgeport 2, Connecticut.

**Registered Trade-mark General Electric Company*

You can put your confidence in—

GENERAL ELECTRIC

WIRE AND CABLE IDEAS for Product Designers

Magnet Wire: For Class H applications (for 180 C and even higher temperatures) G-E Deltabeston* is supplied with silicone-varnish impregnation. This applies to Deltabeston magnet wire insulated with either glass or asbestos.

Handy Booklet: 24-page booklet for product designers. Contains charts, specifications, applications for the standard line of G-E wires, cables, and cords. For daily reference. Write for your copy.

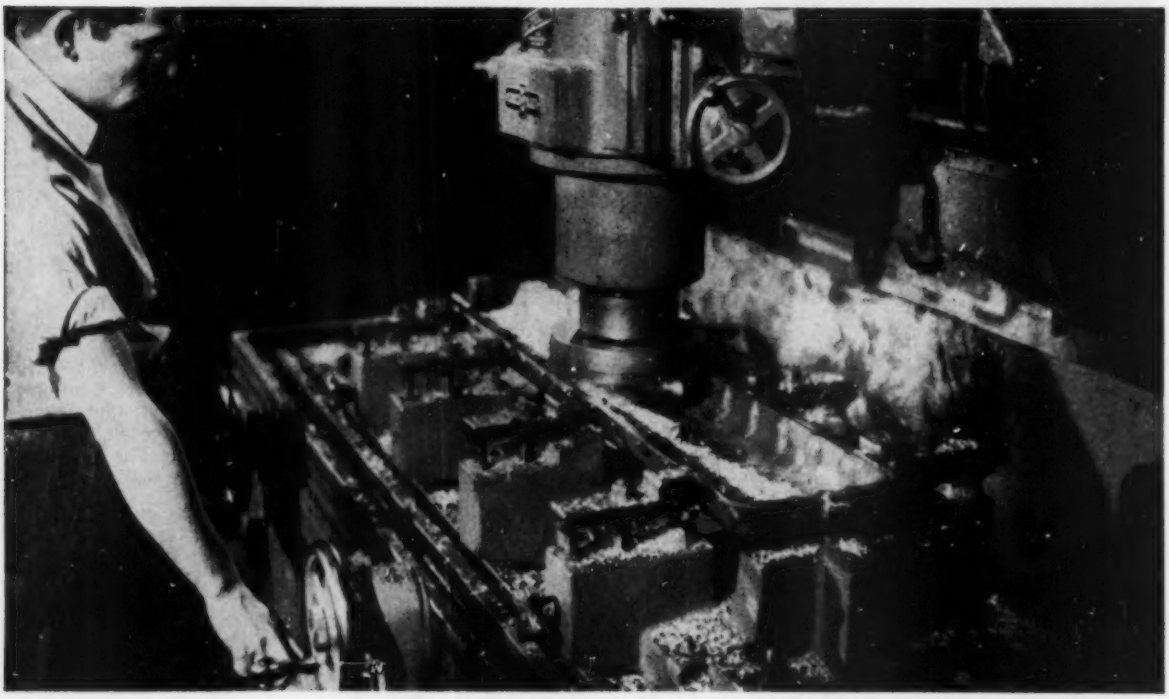
Special Applications: Call on G.E. when your application requires a special cable construction. We have assisted many designers in the past. We want to help you.

Flamenol: General Electric's Flamenol* appliance wire has long-lasting, thermoplastic insulation. Flamenol wire is almost completely resistant to oils, acids, alkalies, moisture, ozone, and sunlight — will not support combustion. Where long life is important and space is limited, G-E Flamenol wire may be your answer.

DOW

MAGNESIUM OFFERS YOU SUPERIOR MACHINABILITY

Increased tool life and lower machining costs are possible



Of all structural metals, magnesium is the easiest to machine. Heavier depths of cut and higher rates of feed than are used on other metals are possible when machining magnesium.

With increased machining speeds, magnesium helps you realize savings in production costs, particularly when extensive machining operations are required.

Magnesium cuts freely, too, assuring increased tool life. In fact, the life of high-speed steel cutting tools when machining wrought magnesium equals the life of carbide-tipped tools on other metals.

Excellent surface finish is obtainable when machining magnesium because there is no tendency for metal to tear or drag. Extremely accurate parts with dimensional tolerances of only a few ten thousandths of an inch can be made by standard machining operations.

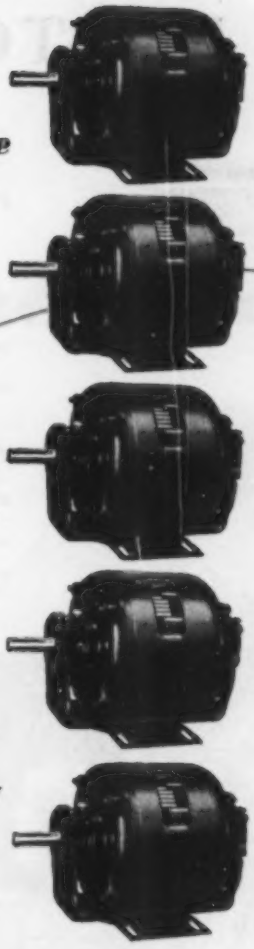
Free Book: "MACHINING MAGNESIUM". This fact-filled book will give you complete data on all machining operations with magnesium. It also includes information on tool design, coolants and shop practice. For your copy, call your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, *Magnesium Department*, Midland, Michigan.

you can depend on DOW MAGNESIUM

DOW

year in . . . year out . . . more and more appliance manufacturers turn to

PACKARD ELECTRIC MOTORS



for:

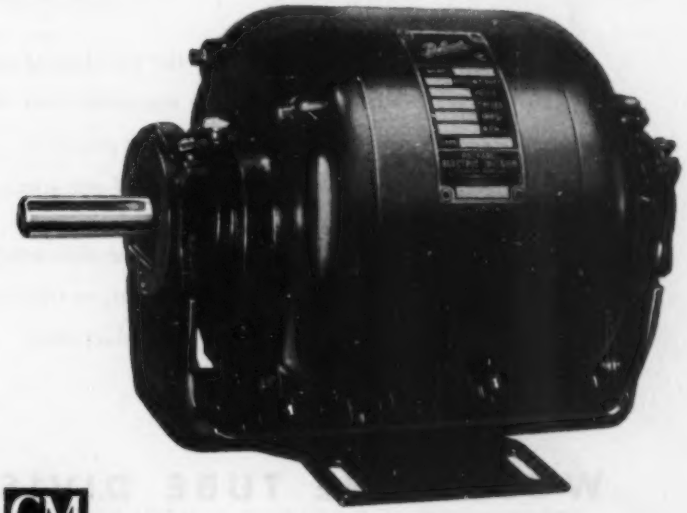
DRYERS
WASHERS
IRONERS
WATER PUMPS
LAWN MOWERS
OIL BURNERS
BLOWERS
VENTILATING UNITS
STOKERS
DISPOSAL UNITS
BENCH TOOLS
COMPRESSORS
MILKING MACHINES
CREAM SEPARATORS

Manufacturers who produce motor-powered products in volume know from experience the advantages of using motors of Packard Electric. A motor especially adapted to the product fits better in the space available . . . provides correct starting and operating torques . . . is built to stand up on the job.

If you manufacture a motor-powered product, Packard Electric engineers can help . . . can design the motor that will assure you of satisfactory product performance for your customers. And Packard Electric, with its tremendous facilities, can mass produce the motor for you—at low cost.

That's why we suggest you talk with Packard Electric about any motor problem. Packard can provide the right motor for you.

DEPENDABLE APPLIANCE MOTORS FOR THIRTY-SIX YEARS



GM GENERAL MOTORS

Packard

REG. U.S. PAT. OFF. TRADE MARK

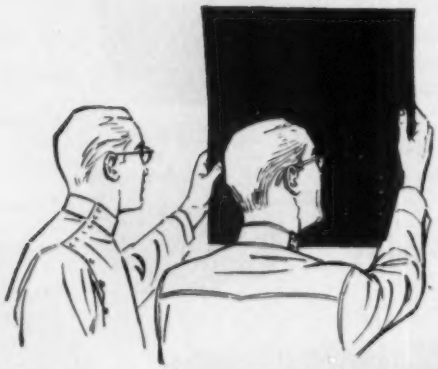
Packard Electric Division
General Motors Corporation
Warren, Ohio

THE DOCTOR'S DOCTOR

THERE is more to the selection of tube than meets the eye.

You will readily agree that first you must learn "where the tube will be used—and under what conditions" before you are able to select the proper tube.

Some have aptly termed us the "Doctor's Doctor". On modest reflection, we accept the designation and the responsibility of prescribing the correct tube for specific applications much as "The Doctor's Doctor"



Having performed countless "cures" we have naturally earned the reputation throughout industry.

And why not? Today's "cures" result from yesterday's education—encompassing over 36 years' experience in tube manufacture and tube application. Many of the "cases" we have encountered during this long period were of the very kind from which you may now be seeking relief.

Whenever you face the problem of selecting tubes of the right alloys with respect to the materials they must handle under certain conditions, you'll find it most practical to invite our Customer Engineering Service to have one of our specialists counsel with you.

Any of these tubes can be delivered to you immediately from our nearest Mill or Mill Depot, or they can be fabricated to any desired form according to your blueprints.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.

ESTABLISHED 1916

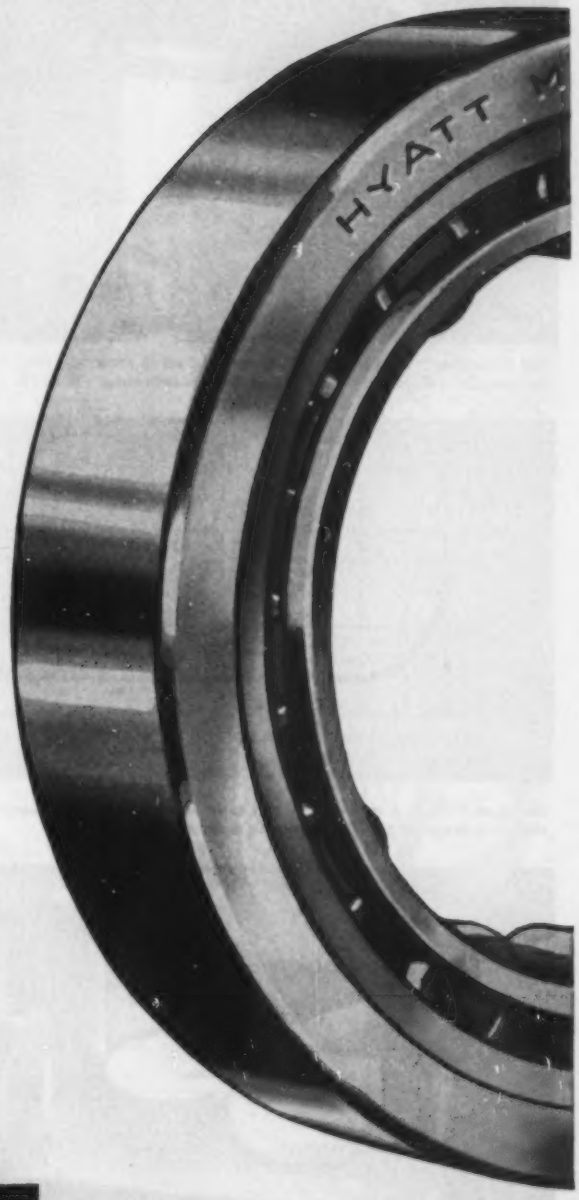
Manufacturers of Quality-Controlled Tubing

1415 CENTRAL AVENUE • DETROIT 9, MICHIGAN

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

EXPORT DEPT. 13 E. 40th St. New York 16, N. Y.

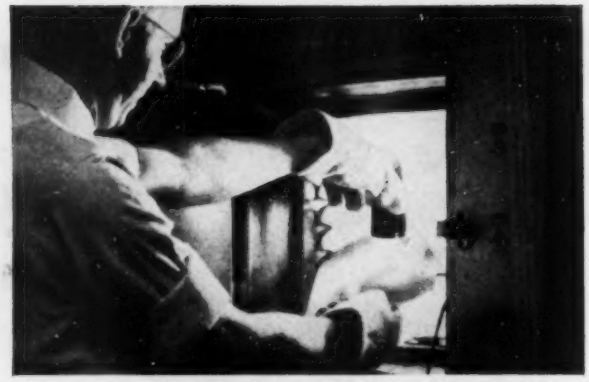
10 designs for heavy duty



Ten different Hyatt Hy-Load designs, each in a variety of widths and sizes, assure you the right bearing for every radial need.
Four Hy-Load designs have separable inner races, two have separable outer races and four are non-separable. All are high-capacity, cylindrical roller bearings for the heaviest radial loads and light or intermittent thrust loads.
All separable parts are freely interchangeable within the same size. This permits non-selective fitting after pre-assembling the two bearing parts in separable machine elements.
Whatever your radial load problem, Hyatt Hy-Loads or some of the other types of Hyatt bearings can provide the answer. Because Hyatt offers industry's most complete line of straight radial roller bearings. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

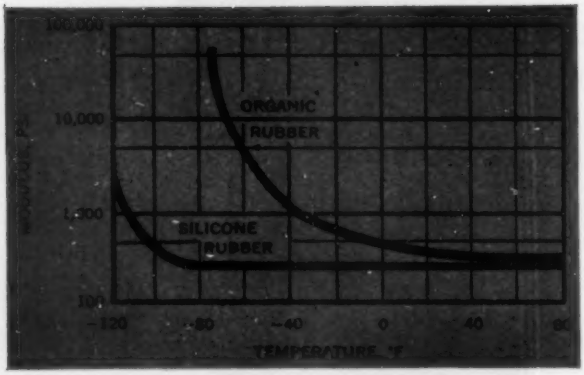
REMARKABLE DESIGN
NEW SILICONE
DEMONSTRATED BY TEST...



High temperature resistance: Elevated temperatures have no appreciable effect on the 1000-1200 volts per mil dielectric strength of glass cloth coated with SE-100.

SE-100—IDEAL FOR ELECTRICAL AND MECHANICAL APPLICATIONS!

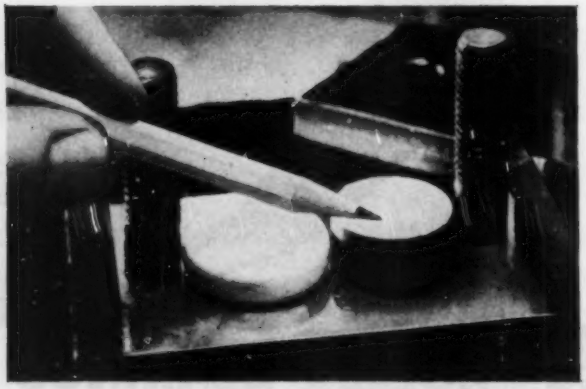
General Electric's new silicone rubber coating compound, SE-100, combines outstanding heat resistance, electrical and physical properties for a wide variety of electrical and mechanical applications. SE-100 may be coated on glass or organic fabrics for service at high or low temperatures or where resistance to weather, ozone, corona or chemicals is required.



Flexible at −120 F: A glance at the blue curve shows the difference (Young's Modulus in flexure) of SE-550 versus organic rubber after 24 hours.

SE-550—STILL FLEXIBLE AFTER 24 HOURS AT −120 F!

G. E.'s new extreme low-temperature silicone rubber, SE-550, combines high strength and elongation with maximum low-temperature usefulness. SE-550 shows practically no increase in modulus at −100 F and retains useful flexibility at −120 F. This flexibility is achieved without sacrifice of high-temperature resistance or any of the other desirable properties inherent in silicone rubber.

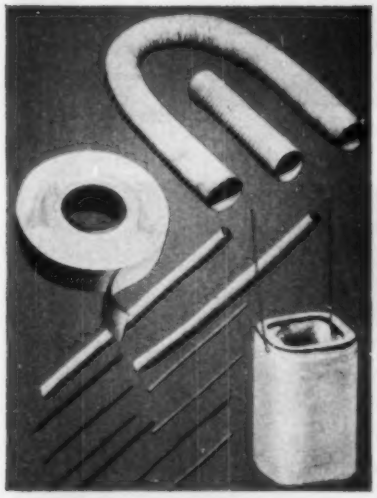


Compression test: Same-size pieces of ordinary silicone rubber and SE-360 are compressed for 22 hrs. at 350 F. Note how SE-360 (right) "comes back" to original size.

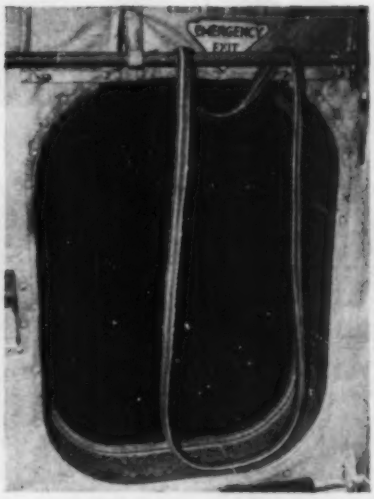
SE-360—MORE "COME BACK" THAN ANY KNOWN RUBBER!

G. E.'s new low compression set silicone rubber, SE-360, is designed to provide more positive sealing action in parts subject to compression at elevated temperatures. In addition to its outstanding low compression set, SE-360 has unusually low shrinkage when cured. This means parts with more uniform properties, closer tolerances and opportunities for your fabricator to cut scrap loss.

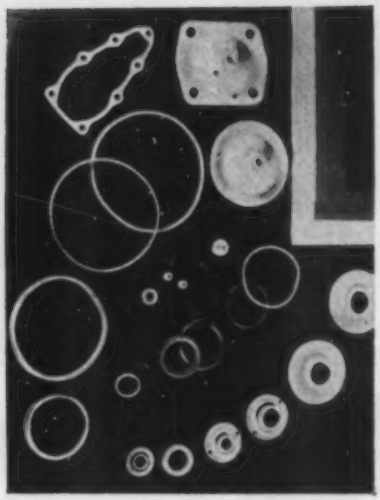
POSSIBILITIES OF THREE GREAT
RUBBER COMPOUNDS
CONFIRMED BY APPLICATION



G.E.'s SE-100 silicone rubber is finding steadily increasing application in the electrical industry for coating cloth, tapes and sleeving; for coating glass-served wire; for encapsulating coils. Among the many mechanical uses for SE-100 are ducts and tubing; gaskets and seals; diaphragms.



Gaskets for emergency hatches (shown here at 50 below zero F) astra domes and access windows on the Douglas Globemaster are now made of G.E.'s SE-550 silicone rubber because it remains flexible and maintains a seal at extremely low temperatures; does not stick to metal after long inactivity.



O-rings, gaskets and seals are being designed with G.E.'s new SE-360 silicone rubber for applications where sustained resilience at high temperatures is required. Aircraft, automotive and railway design engineers find SE-360 ideal for jet engine parts, transmission seals and Diesel gaskets.

CLIP AND MAIL TODAY!

FOR MORE INFORMATION

about these new G-E silicone rubber compounds; just mail the coupon! You will also receive a free copy of "Imagineering with Silicone Rubber" which describes other G-E silicone rubber products and tells how you can put them to work.

You can put your confidence in—

GENERAL ELECTRIC

General Electric Company
Section 353-6B
Waterford, New York

Please send me product data on ( ) SE-100 ( ) SE-550 ( ) SE-360, including a free copy of "Imagineering with Silicone Rubber." I want this information for ( ) Reference purposes only ( ) An immediate application on

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Name_____

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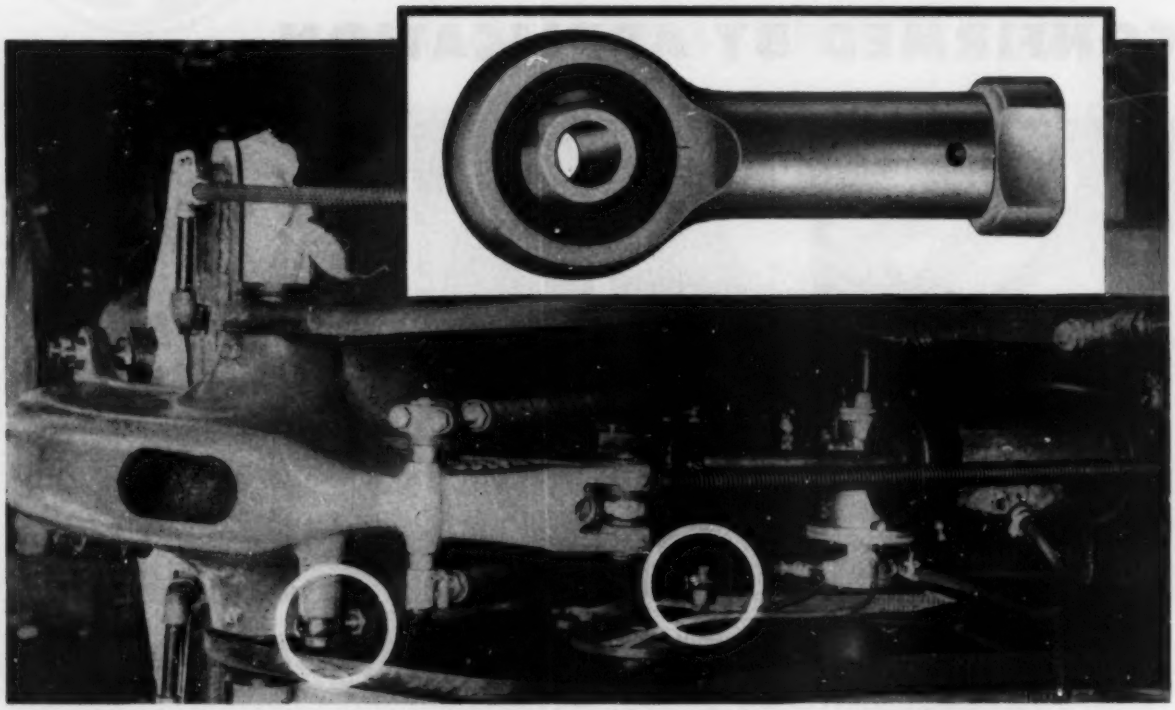
City_____ Zone_____ State_____

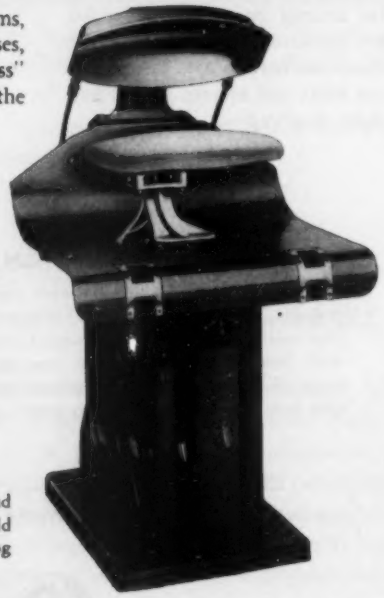
(In Canada, mail to Canadian General Electric Company, Ltd., Toronto)

. . . For Ease of Mounting . . . choose . . .

HEIM Spherical Bearing Rod Ends



Designed for general use in pressing the more difficult small lays on uniforms, smocks, and house dresses, and for finishing small garments such as shorts, blouses, and children's dresses, the "Prosperity Utility Oval Shaper with Square Ends Press" uses Heim Rod Ends as the end members of the connecting link between the hydraulic check and other operating parts.



Heim Rod Ends were chosen for this important linkage not only for their ease of mounting, but because their self-aligning feature was required to compensate for the hydraulic check link and the operating levers swinging out of plane with each other.

To familiarize prospective users of Heim Spherical Bearings and Rod Ends with the unique, single ball construction, we would like to mail you a free sample. Or write for the complete catalog of Heim Bearings.

THE HEIM COMPANY FAIRFIELD, CONNECTICUT

FARVAL SPRAY VALVES save 95% of lubricant and do 100% better job

FARVAL—*Studies in Centralized Lubrication*
No. 149

COUNT the number of open gears on your machines. Multiply the amount of grease required for these gears by 95% and you'll have the savings in lubricant alone which Farval Spray Valves can bring.

Even more important than lubricant saving, the Farval Spray Valve spreads and maintains a uniform thin film of oil or grease evenly over all bearing areas —eliminates friction, increases efficiency, lowers power costs, reduces wear.

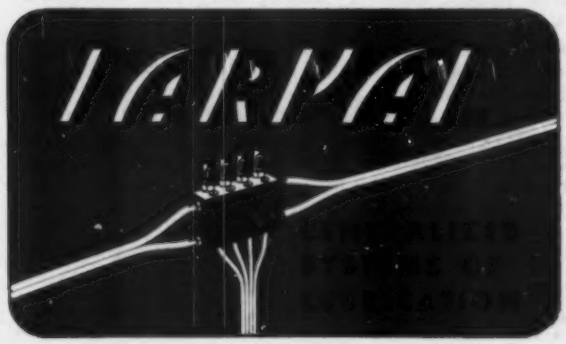
The Farval Spray Valve System is designed especially for lubricating open gearing and slide surfaces. Using an adaptation of the familiar Dualine Valve, this system sprays oil or grease from nozzles in just the right amount and at any desired interval.

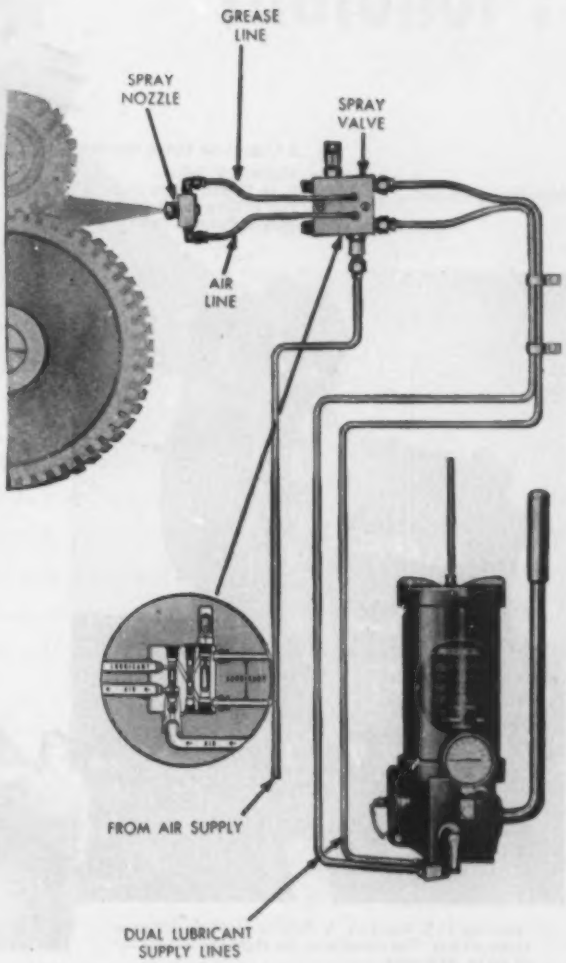
No more wasteful hand paddling of lubricant on gear teeth with the hope it will spread itself uniformly. No more blobs of grease splotching up the floor—creating safety hazards. The Farval Spray Valve System has proved it can maintain a clean, even film of lubricant at all times while machines are in operation. No waste. No mess. No trouble.

Farval Spray Valves can be inserted in a regular Farval Dualine System wherever compressed air is available. Or a complete Farval Spray Valve System may be installed, consisting only of Spray Valves served by a manual or automatic pumping unit. As indicated in the sketch at right, compressed air is directed through the Spray Valve, which meters air to the delivery nozzle at the same time that the lubricant is metered. Positive cut-off after delivery eliminates bleeding.

Why not insure that your open gearing and slide surfaces get the lubrication they need? Write for a copy of Farval Spray Valve Bulletin No. 60 today. The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

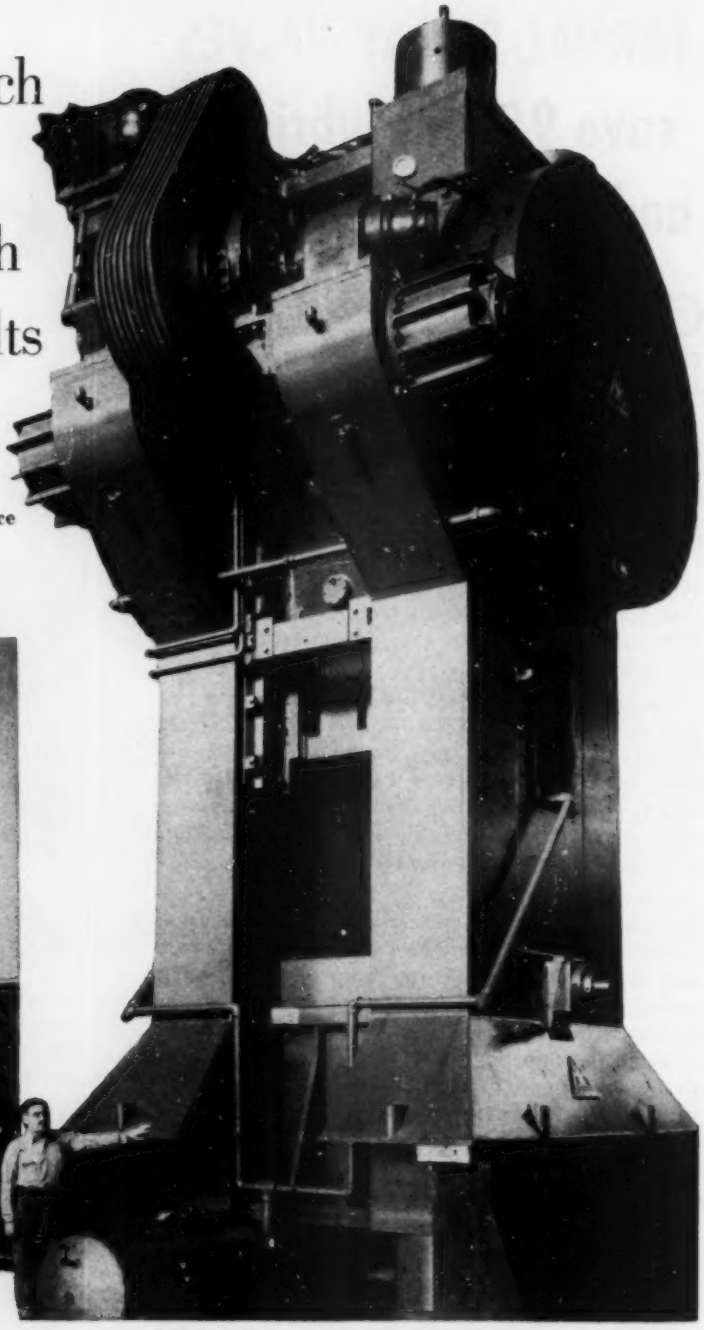




Drawing shows component parts of the Farval Spray Valve Centralized System of Lubrication—manual pumping station, dual lubricant lines, compressed air line, single Spray Valve and nozzle. Both automatic and manual systems installed three years ago are in operation today, prolonging gear life, saving labor and lubricant.

Controlling the punch of mighty heavyweights...with U.S. Rainbow® V-Belts

A Complete Drive Service
Multiple V-Belts
F. H. P. Belts, Sheaves
Flat Belting and Belting
Special Purpose Belts



Note the U.S. Rainbow V-Belts in multiple drive on these presses. The monster at the right has a capacity of up to 3000 tons.

These powerful presses, used for forming steel, exert tremendous forces. The V-Belts that transmit this power must be capable of handling great shock loads. The belts designed by United States Rubber Company for these presses have the right strength and dependability for the job. Each belt has the unique Equa-Tensil Cord Section that scientifically distributes the load to insure efficient pull with minimum stretch. Protective jackets increase the grip while keeping out dirt and prolonging wear. For large or small drives, you can depend on the quality of U.S. Rainbow V-Belts. Order from your jobber or contact any of the 25 "U.S." District Sales Offices, or write to address below.

U.S. RUBBER
SERVING THROUGH SCIENCE

"U.S." Research perfects it...
"U.S." Production builds it...
U.S. Industry depends on it.

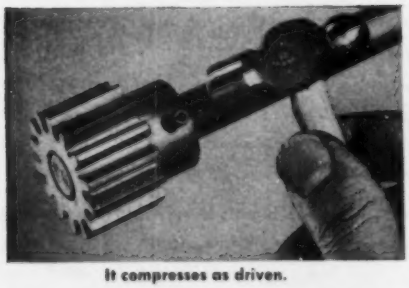
UNITED STATES RUBBER COMPANY
MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

Where can you use this simple fastener?

Rollpin is driven into holes drilled to normal production-line tolerances.

No threading, peening or precision drilling with ROLLPIN



It compresses as driven.

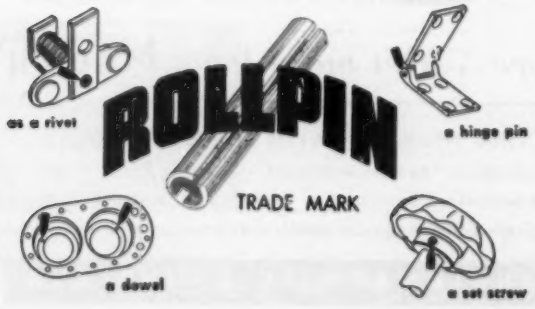
Rollpin fits flush . . . is vibration-proof.

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

This modern fastener drives easily into standard holes, compressing as driven. Its spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole.

* * *

If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your costs. Mail our coupon for design information.



Elastic Stop Nut Corporation of America
Dept. R16-82, 2330 Vauxhall Road, Union, N. J.
Please send me the following free fastening information:

☐ Rollpin bulletin
☐ Elastic Stop Nut bulletin
☐ Here is a drawing of our product. What fastener would you suggest?

Name _____ Title _____
Firm _____
Street _____
City _____ Zone _____ State _____

This NEW 25-WATT Power Rheostat Makes The Mallory Line Complete

A FULL range of 8 different sizes of Mallory Power Rheostats, from 25 to 500 watts in a wide range of resistance values, is now available to meet all your requirements.

Mallory Rheostats give you the advantage of more precise linearity, because of the extreme accuracy of Mallory's exclusive wire winding technique.

They also give long dependable performance, because each Mallory Rheostat is designed for adequate ventilation . . . windings are sealed into position around a high quality ceramic core by a protective coating of porcelain vitreous enamel . . . all current carrying parts are insulated by dimensionally stable ceramic parts.

Mallory Power Rheostats can be supplied in tapered windings and tandem construction. For complete details, let us send you a copy of a new Technical Bulletin on Power Rheostats.

THE HINGED CONTACT ARM

is another important feature . . . exclusive with Mallory.

It maintains constant contact pressure, yet permits easy inspection and cleaning of the brush.

The tension spring carries no current. There is no danger of annealing during overloads.

Springs are preset to optimum tension in relation to wire size and current rating.

Expect more . . . Get more from MALLORY

P R MALLORY & CO Inc

MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. INC., INDIANAPOLIS 6, INDIANA

Restores worn car wheels automatically

. . . with help of TIMKEN® bearings

THIS Niles 52" car wheel lathe, manufactured by Baldwin-Lima-Hamilton Corporation, roughs and finishes worn car wheels automatically—all in one operation! A hydraulic stylus follows a predetermined contour of the profile. Special micrometers and calipers measure and gage the wheels to determine the amount of material to be removed in re-profiling the wheel contours.

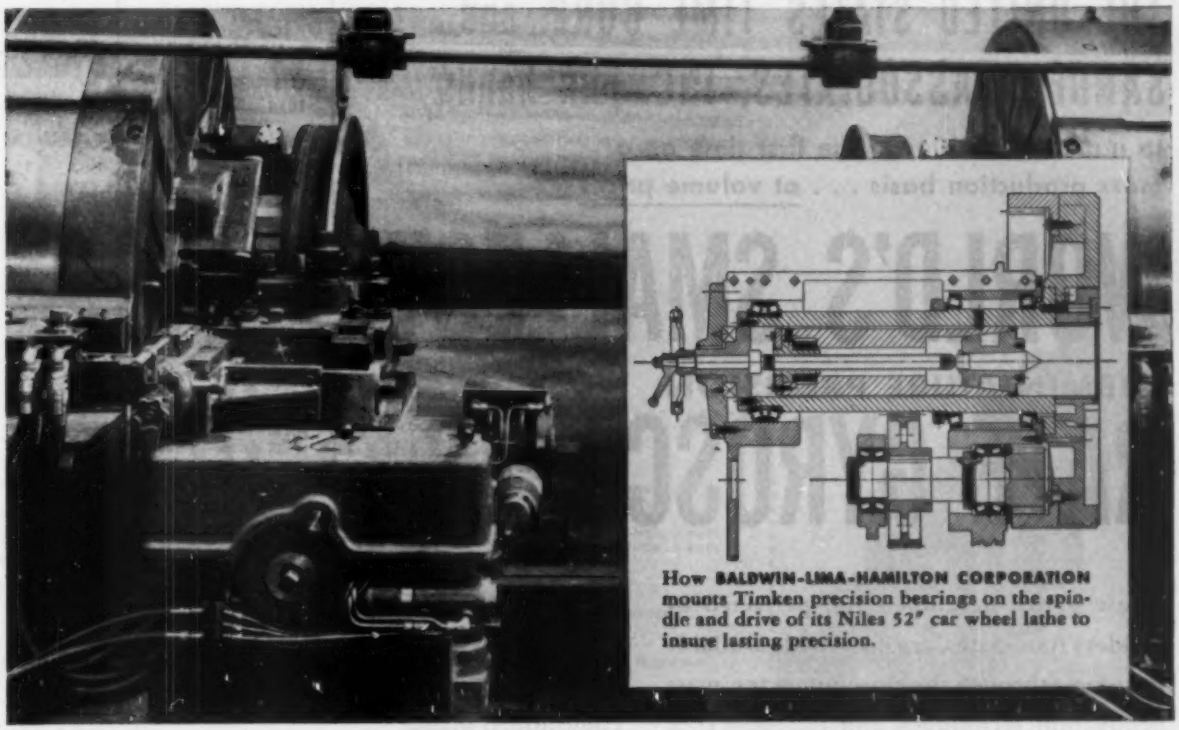
To maintain the high precision necessary, Niles mounts the lathe spindle on Timken® tapered roller bearings. Because of line contact between their rollers and races, Timken precision bearings have extra load-carrying capacity. Their tapered construction takes both radial and thrust loads, permits pre-loading to any desired degree. Result: deflection is minimized, long-lasting accuracy is assured.

To help turn the heavy load of the wheels and axles smoothly, Timken bearings are also used in the drive. They hold shafts in alignment, insuring accurate gear mesh, longer gear life.

Timken bearings are easy and less costly to assemble. Manufacturing costs are reduced. Auxiliary thrust bearings are eliminated, maintenance is simplified.

No other bearing can give you all the advantages of Timken bearings. Make sure you have them in the machine tools you build or buy. Always look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **BALDWIN-LIMA-HAMILTON CORPORATION** mounts Timken precision bearings on the spindle and drive of its Niles 52" car wheel lathe to insure lasting precision.

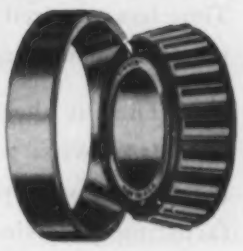
MAGNIFYING GLASS INSPECTION OF EVERY ROLLER!

Every one of the over one billion Timken bearing rollers produced every year is inspected with powerful magnifying glasses to detect surface flaws. It's just one example of how the Timken Company insures uniform high quality.

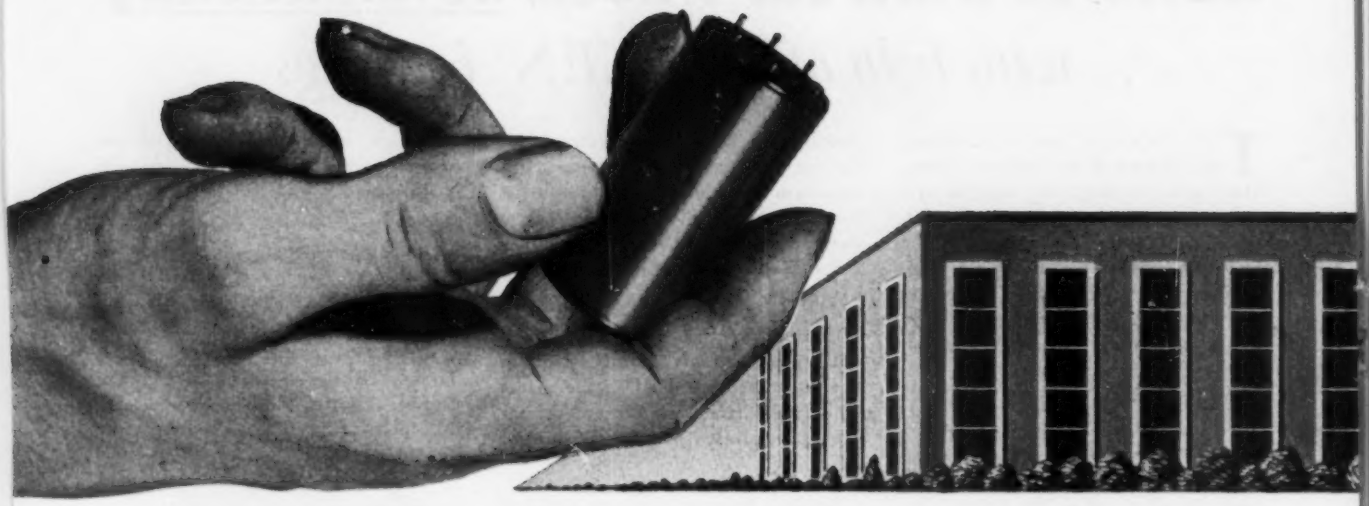
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL **NOT JUST A ROLLER** **THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION**



THE UNITED STATES TIME CORP. and SANDERS ASSOCIATES, INC. join hands

to make available for the first time on a mass production basis . . . at volume prices—

WORLD'S SMALLEST SUBMINIATURE PRECISION RATE GYROSCOPES

LESS THAN **1** INCH DIAMETER

LESS THAN **2** INCHES LONG

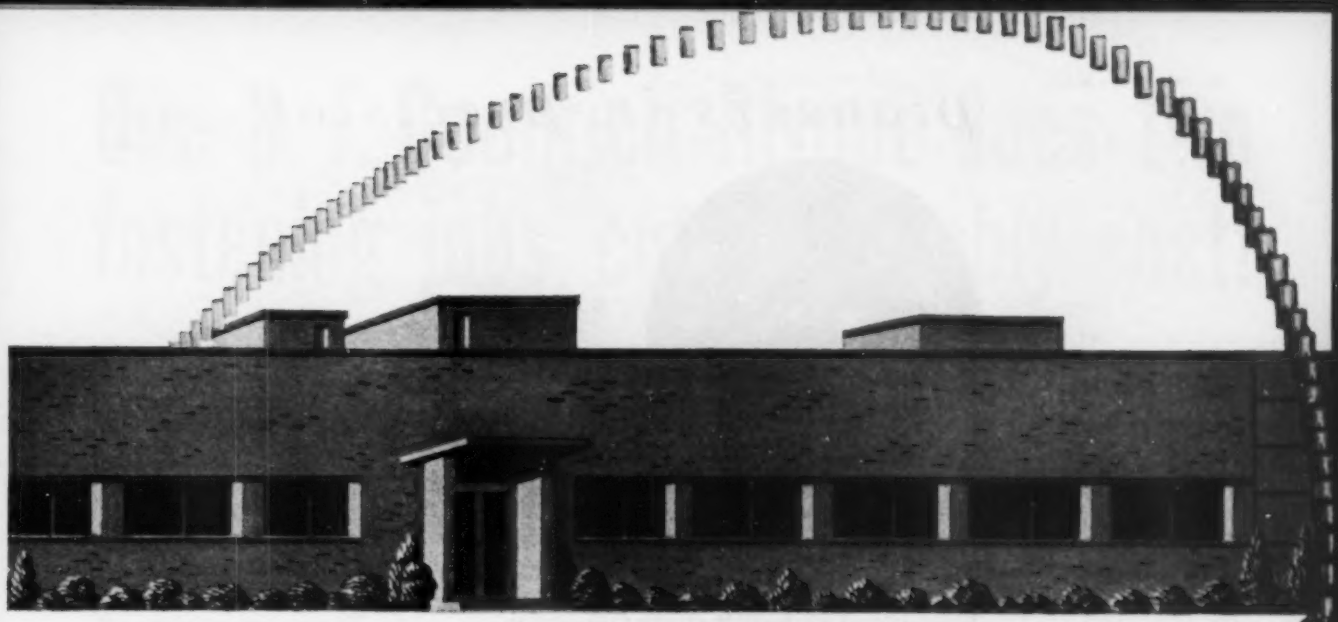
LESS THAN **3** OUNCES

These gyros, developed and perfected by Sanders Associates, are now made available in volume through the close-tolerance, mass production techniques and facilities U. S. Time has acquired in nearly a century of precision manufacturing experience.

U. S. Time is the world's largest manufacturer of wrist watches and mechanical time fuses. Twelve years ago it began manufacturing precision gyroscopes for the armed forces. During this period, it has produced gyros at the rate of *17,000 per month* in its ultra-modern, completely air-conditioned plant.

Now—the skills and experience gained in attaining this outstanding record in mass precision production are being applied to the manufacture of Sanders Associates' Rate Gyro—the ultimate in subminiaturization, flight proven in production missiles.

another design



SUPERIOR PERFORMANCE CHARACTERISTICS
RELIABILITY ACTUALLY INCREASED

- temperature compensated
- hermetically sealed
- fast starting
- high resonant frequency
- unusually insensitive to shock and vibration

CHARACTERISTICS

Range	...420 degrees/sec.	40 degrees/sec.
Resolution	better than 0.05 degrees/sec.	better than 0.005 degrees/sec.
Linearity	approximately 0.1%	
Sensitivity	5.6 volts RMS AC output at 420 degrees/sec.	5.6 volts RMS AC output at 40 degrees/sec.
Resonant Frequency	85 CPS	30 CPS

Nominal Damping	..0.5 critical	0.5 critical
Motor Excitation	... 6.3 volts, 400 cycles, 2 phase, 3 watts 26.0 volts, 400 cycles, 2 phase, 4 watts	
Pickoff Excitation	...6.3 volts, 400 cycle	
Starting Time	.....	15 seconds
Max. Operating Linear Acceleration	60 G any axis	20 G any axis

ENVIRONMENTAL CONDITIONS

Altitude — 0-60,000 feet
Temperature Operating Range — -55C to 85C
Max. Survival Shock Acceleration — 1000 G any axis
Tested Operating Life — over 1000 hours
Max. Vibration (0-300 CPS)...5 G any axis

VARIATIONS IN DESIGN POSSIBLE TO MEET SPECIFIC REQUIREMENTS

INQUIRIES INVITED. **Write to Dept. C.**

The United States Time Corporation

500 FIFTH AVENUE, NEW YORK 36, N. Y.

Main Plant — Middlebury, Connecticut

Other Plants — Waterbury, Connecticut; Little Rock, Arkansas, Abilene, Tex., Dundee, Scotland

ACTUAL SIZE

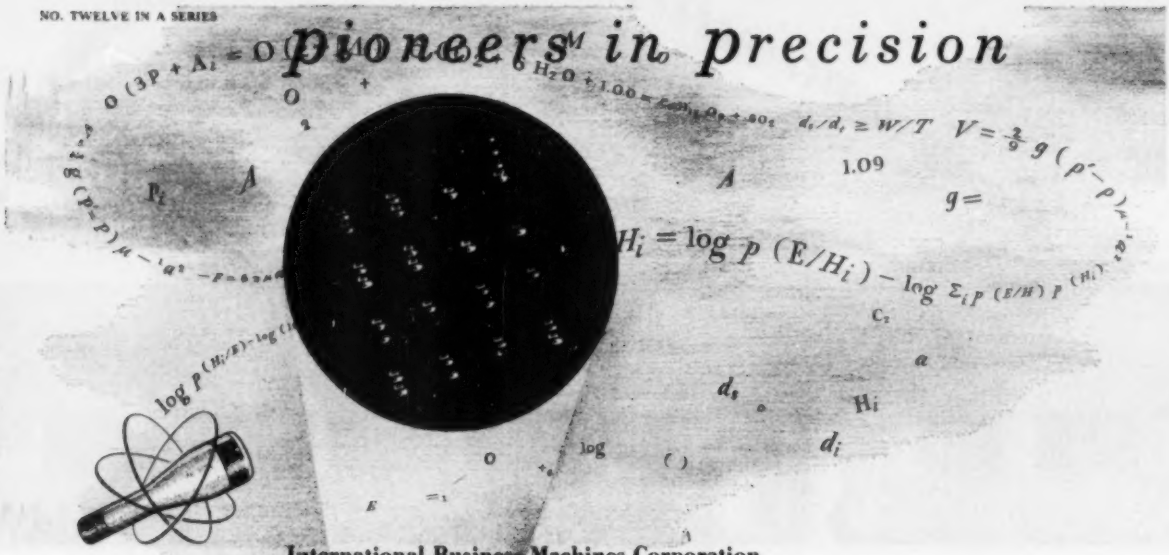
SUITABLE FOR:

GUIDED MISSILES
FIRE CONTROL SYSTEMS
AIRCRAFT INSTRUMENTS
ANTENNA STABILIZATION

US TIME

NO. TWELVE IN A SERIES

pioneers in precision



International Business Machines Corporation
recently installed the first production model of the IBM high-speed electronic calculator, the "701." Most recent successor to the pioneer large-scale digital calculator first developed by IBM in 1944, the "701" solves in minutes a problem which would take one man, using a desk computer, seven years to complete.

Miniature Precision Bearings, Incorporated,
are the originators and pioneer developers of precision ball bearings in miniature sizes (1/10" to 5/16" o.d.). Exclusive **MPB** methods assure thousands of discriminating customers ultra quality bearings for vital equipment.

MPB ball bearings supply the unerring accuracy and proven dependability necessary in providing many devices with anti-friction qualities. **MPB** ball bearings function effectively with deft delicate responsiveness under extreme operating conditions. They are fully ground, lapped, honed, and/or burnished to ABEC 5 tolerances or better.

The possibilities offered by **MPB** ball bearings are being profitably explored by leading instrument makers of the future. We would welcome the opportunity to discuss the matter with you. Branch offices in New York and Boston and Engineering Representatives in Principal Cities are eager to serve you. Ask for detailed data sheets PE 8.

Immediate delivery on most sizes and plant capacity to promptly meet your additional requirements.

Miniature *precision* Bearings

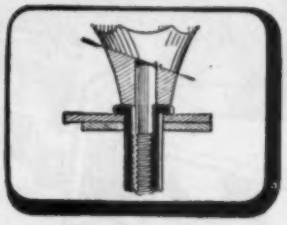
Incorporated MPB Keene, New Hampshire

"pioneer precisionists to the world's foremost instrument manufacturers" { *save space weight friction*

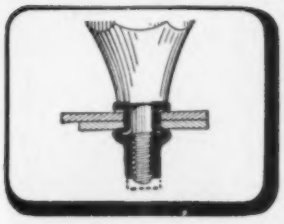
One B. F. Goodrich Rivnut does two fastening jobs, cuts assembly cost!

Rivnuts provide at least 6 clean threads in one simple operation!

1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



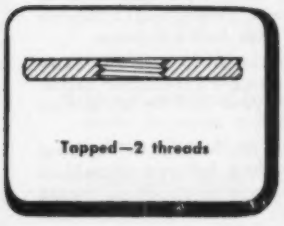
2. Rivnut is inserted—head firmly against work—tool at right angles to work.



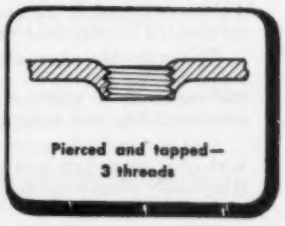
3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4. After upset, Rivnut threads are still clean and intact, ready for screw attachment.

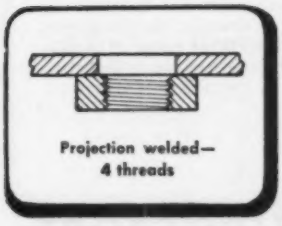
Compare these 4 methods of putting screw threads in thin sheet metal



Tapped—2 threads

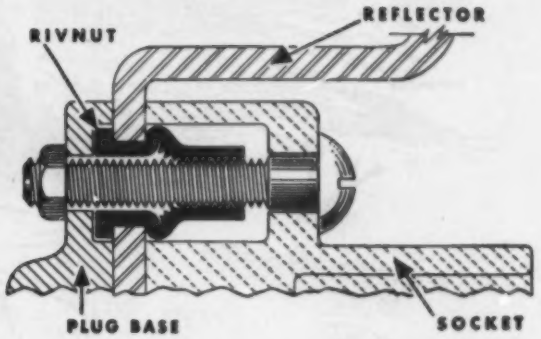


Pierced and tapped—3 threads



Projection welded—4 threads

Rivnut—at least 6 threads



B. F. GOODRICH RIVNUTS cut assembly time and costs since they provide a firm, accurate nut plate in one quick operation. Welding, tapping are eliminated. Rivnuts can be installed from *one side* and can take an attachment bolt from either end.

In the application above (assembling spotlights) Rivnuts completely eliminated use of threaded studs which required welding in close quarters. They also eliminated a separate piercing and tapping operation and made it possible to attach nuts from the outside of the assembly instead of the inside. Rivnuts provided further cost savings since they could be attached *after* enameling without marring the finish of the unit.

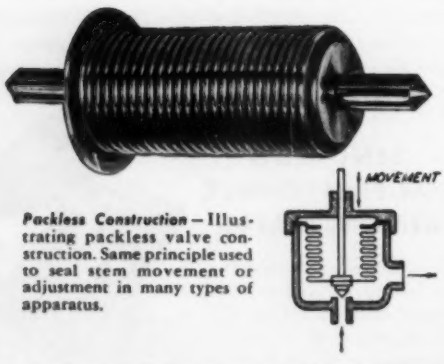
Whatever your fastening problem, there's probably a B. F. Goodrich Rivnut that can cut both assembly time and costs. Get complete information and engineering help by calling in a B. F. Goodrich Rivnut engineer. *The B. F. Goodrich Company, Department A-53, Akron, Ohio.*

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department A-53, Akron, Ohio.

B.F.Goodrich RIVNUT *The only one-piece blind rivet with threads*

A SPECIALIST DOES IT BEST!



Packless Construction — Illustrating packless valve construction. Same principle used to seal stem movement or adjustment in many types of apparatus.

● If your products or product plans require bellows assemblies, you can get real help from specialists at Fulton Sylphon or Bridgeport Thermostat. They've specialized in this field for over half-a-century.

This valuable experience can help you in many ways. Skilled personnel and ample production facilities are ready to take care of your bellows assemblies needs quickly and accurately.

And our specialists are equally helpful in working with you to design and produce bellows assemblies specifically adapted to your requirements. On all counts you save time, production worries and expense.

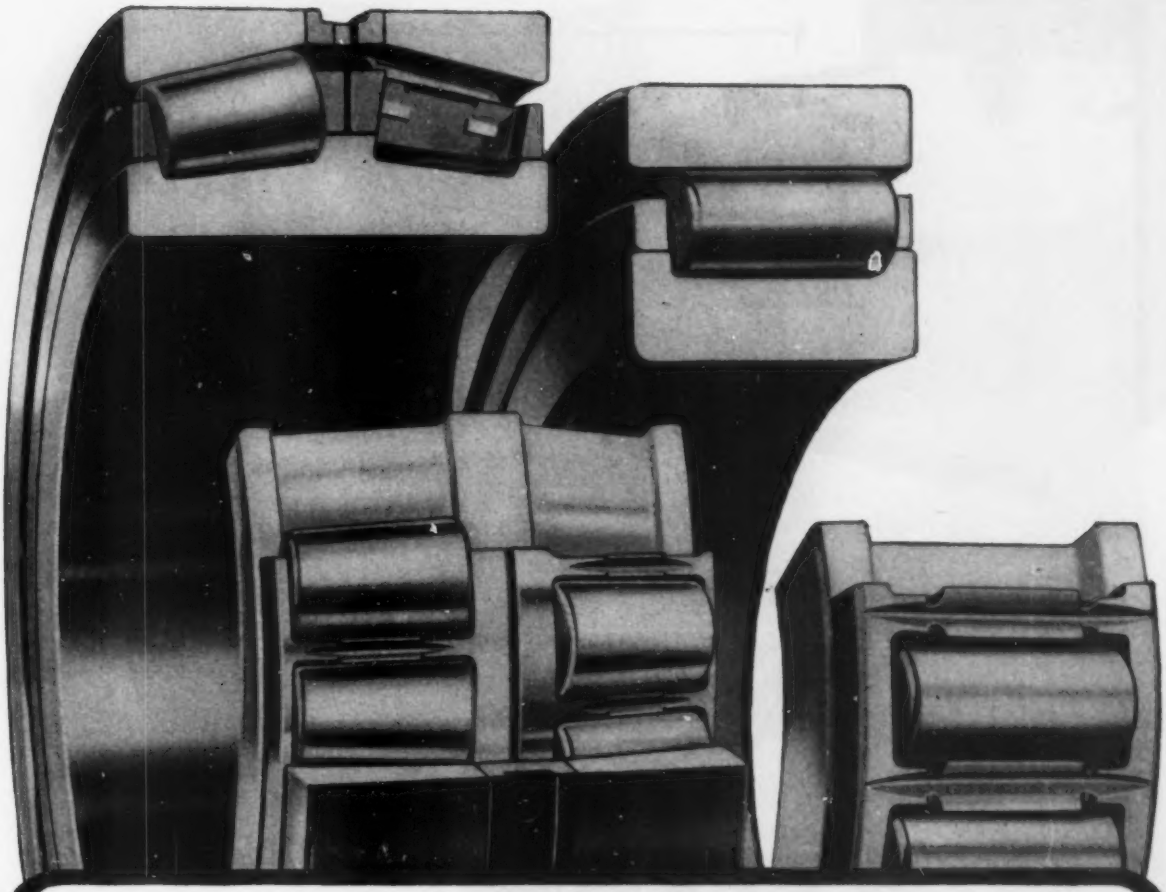
Sylphon and Bridgeport bellows assemblies are used in many ways—as flexible connectors, for thermostatic devices, pressure controls, hydraulic mechanisms, expansion joints and other units. Wide range of metals and sizes. Write for information. Ask for helpful, idea-filled Catalog PP-1400.

FULTON SYLPHON
DIVISION
Knoxville 1, Tenn.

Robertshaw-Fulton
CONTROLS COMPANY
EVERYTHING'S UNDER CONTROL

TEMPERATURE CONTROLS • BELLOWS ASSEMBLIES • BELLOWS DEVICES

BRIDGEPORT THERMOSTAT
DIVISION
Bridgeport 1, Conn.



TORRINGTON

TAPERED and CYLINDRICAL ROLLER BEARINGS

Give you these BIG ADVANTAGES

- **One-piece cast-bronze cages with machined pads in each roller pocket**—to assure accurate guiding of rollers.
- **Stabilized races**—to maintain accuracy of fit, improve bearing performance.
- **Individual roller retainment**—to assure adequate lubrication at roller, simplify inspection of race surfaces.
- **Precision tolerances and finishes on both rollers and races**—for minimum eccentricity and equal load distribution.
- **Controlled quality steels**—by use of electric furnace steels, through-hardening or case-hardening grades, and modern heat-treating methods—for increased bearing capacity and longer life.
- **Interchangeability**—in all types and sizes.

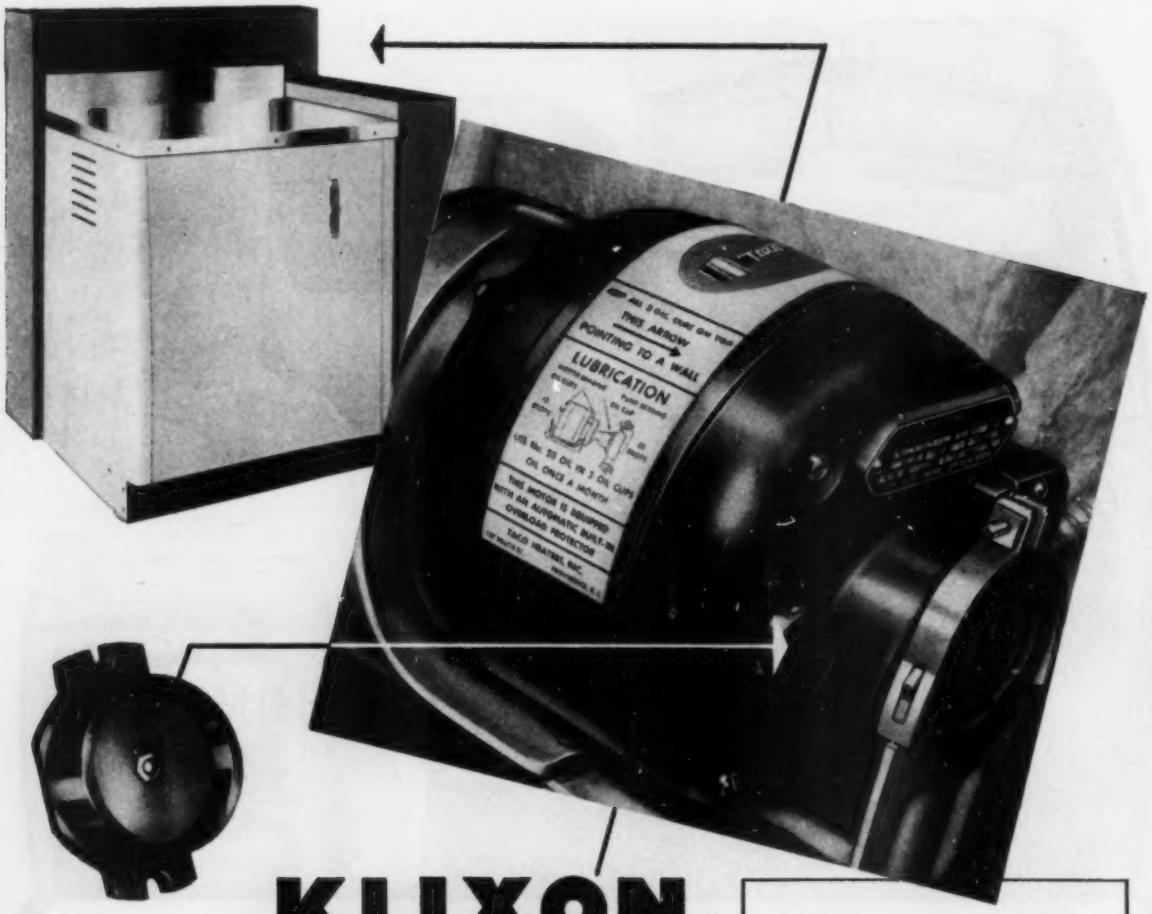
Backed by custom engineering to meet your load and speed requirements, these advantages add up to maximum performance for your bearing dollar. That's why it always pays to specify TORRINGTON!

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers



KLIXON PROTECTORS

Help keep the "heat on" in York-Shipley Boiler Units

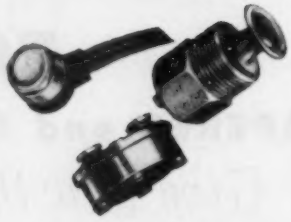
Modern in design, compact for space saving, the York-Shipley oil-fired, table-top boiler units provide plenty BTU's for outstanding home and hot water heating.

York-Shipley engineers specify and use motors with built-in Klixon Protectors to insure dependable, long-lived motor operation.

Here's what Mr. H. Leroy Mohn, project engineer, has to say about Klixon Protection:

"We prefer Klixon built-in motor protection in our oil burner and circulating pump motors because we find they reliably protect motors against unusual load conditions. Our experience with these protectors has been excellent."

You, too, can keep motors in your equipment operating, reduce service calls and repairs by specifying and using Klixon protected motors. The additional cost is low, pays for itself over and over by reducing motor burnouts.



KLIXON THERMO-SNAP TEMPERATURE CONTROLS

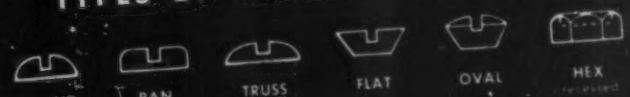
Actuated by the snap-acting Spencer Disc, these controls open the circuit with a quick, clean break; close with a solid make. Their accurate operation withstands shock, vibration, motion and altitude. Used in military and commercial applications ranging from tanks, aircraft, sterilizers, radio and electronic equipment to household appliances. Available in many types and ratings including hermetically sealed units.

KLIXON

SPENCER THERMOSTAT
Division of Metals & Controls Corp.
908 FOREST ST., ATTLEBORO, MASS.

TAPPING SCREWS

TYPES OF TAPPING SCREWS



AVAILABLE WITH SLOTTED, CLUTCH OR PHILLIPS HEAD RECESSES

POINTS AND THREADS		METAL THICKNESS	HOLE DIAM	POINT DIAM
TYPE "A"	Spaced thread with gimlet point. Use in light sheet metal, resin impregnated plywood, asbestos compositions etc.	From .018 To .048	.128 To .149	Sharp for easy starting
TYPE "B"	Spaced thread with pitches finer than type "A" but with same general uses. Blunt point for better appearance. Point requires less space.	From .018 To .073	.144 To .173	.130 .125
TYPE "C" COARSE OR FINE THREAD	Thread similar to machine screw threads. Used where a machine thread is preferable. May be used with machine nut for extra strength. Requires higher driving torques than "A" or "B"	From .037 To 5/16	.154 To .177	.147 .133

*These specs apply to tapping screws in sheet steel

*In selecting Tapping Screws it is extremely important to understand the proper application for each type. The type you require will vary with: 1. kind of material; 2. thickness of material; 3. the method used for making the hole.**

Lamson Tapping Screws are precision made to insure maximum holding even in thin material, fully hardened to permit the thread crests to form clean threads without stripping hole. They are available in a wide range of head and point combinations. A "special" Tapping Screw to many . . . is a "stock" item at Lamson.

**This information is available in tabular form for easy reference. Write for as many copies as you need.*

The LAMSON & SESSIONS Co.
1971 West 85th St. • Cleveland 2, Ohio
Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

Lamson + Sessions

FOR PROMPT DELIVERY AND HELPFUL SERVICE, ORDER FROM YOUR LAMSON DISTRIBUTOR

PLUG NUTS — Ideal for blind or hard-to-reach places.

PIPE PLUGS — Forged steel, heat-treated.

"1835" SET SCREWS — Cup point type, hardened and heat-treated.

PLACE BOLTS — With "Built-in" spring action for positive locking.

LOCK NUTS — Economical, vibration proof. Can be used repeatedly.

"BENT BOLTS" — Including U bolts, eye bolts, hook bolts, etc.

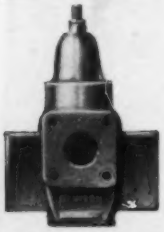
MACHINE SCREWS — Clutch and Phillips recessed head screws.

SEMS — Pre-assembled lockwashers on tapping and machine screws.

BUILT TO TAKE IT

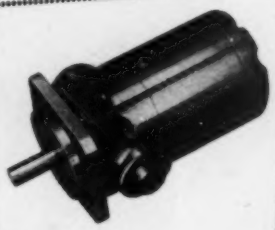
longer, with less maintenance, at pressures up to 5000 psi

SURGE-DAMPING CONTROLS
Industrial and Aircraft Types
Eliminate Destructive Hydraulic Pressure Shock
¼" to 1" Sizes
For Pressures to 5000 psi
Catalog VS-1-A

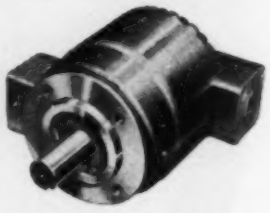


Direct-Operating PRESSURE CONTROLS
½" to 1½" Sizes
For Pressures to 2000 psi
Catalogs VRD-1 through VRD-8

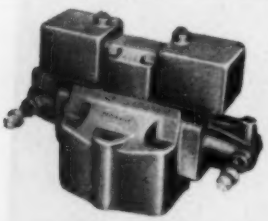
High-Pressure Axial-Piston PUMPS
Constant or Variable Volume
For 2500, 3000 and 5000 psi Circuit Needs
3.5 to 35 gpm Capacities
Catalogs P-4 through P-4-10



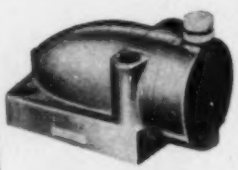
High-Torque Axial Piston FLUID MOTORS
Torque Ratings 13.8 to 112 inch-pounds per 100 psi (about 3 to 180 hp maximum)
For Pressures to 5000 psi
1500 to 3000 rpm
Catalogs FM-1, FM-2, FM-3-A



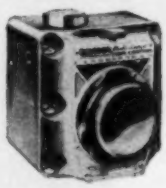
Dual-Purpose, Vane-Type PUMP/MOTOR
Ready for either pump or motor use without change
Shaft rotation in either direction
Four Sizes, 11 Models
Pumping Capacities: 3 to 82 gpm.
Motor Torque: 13 to 257 inch-pounds per 100 psi. Pressures to 2000 psi.
Bulletin P-5



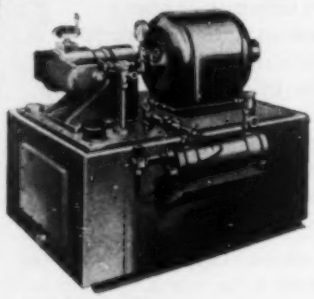
DIRECTIONAL CONTROLS
Manual, Mechanical, Electric or Pilot Control. ¼" to 2" Sizes
For Pressures to 5000 psi
Catalog VD-3



PRESSURE REDUCING VALVES
¾" to 1½" Sizes
20 gpm to 65 gpm Capacities
For Pressures to 5000 psi
Catalog VPR-1



Multi-Range FLOW CONTROLS
Full-Scale Regulation—Adjustable for Varying Input
¼" to ¾" Sizes
For Pressures to 3000 psi
Catalogs VFC-1, VFC-2



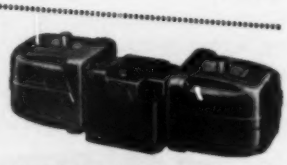
PUMPING UNITS
Constant and Variable Volume
46 Models—2 to 35 gpm Capacities
For Pressures to 5000 psi
Bulletins PU-3-A, PU-4 and PU-5

Denison HydrOILic PUMPS, MOTORS and CONTROLS

Proved in use—under many of Industry's toughest operating conditions—Denison HydrOILic Pumps, Motors and Controls are noted for their combination of high efficiency and rugged dependability.

In addition to fine performance under continuous, heavy-duty use, Denison HydrOILic Equipment offers space-saving design that simplifies circuit layout, makes installation easier, and minimizes maintenance problems.

Because so many users verify the extra value built into Denison Pumps, Motors and Controls, we continue the challenge made so often before—*let comparison prove to you* why they are first choice for so many needs of every type. Write today for full details on Denison HydrOILic Equipment to meet your requirements.



Pilot-Operated, Solenoid-Controlled DIRECTIONAL VALVES
Eliminate Spool-Sticking
¾" to 1½" Sizes, For Pressures to 5000 psi
Catalogs VD-1-1 to VD-4-2

Hydraulically Balanced PRESSURE CONTROLS
¾" to 2" Sizes
For Pressures to 5000 psi
Catalogs VR-2-8 and VR-5-2

The DENISON Engineering Co.
1157 DUBLIN ROAD, COLUMBUS 16, OHIO

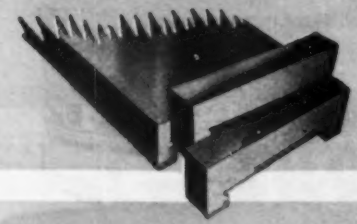
DENISON HydrOILics

"The Finest Money Can Buy!"

HOW HARD are OK hardened ways?

ONE CUSTOMER SHOWED US BY:

1. Taking a section from an OK bedway



2. Making it into a "tool bit"

3. Then cutting metal with it (1045 cold rolled steel)

The Gisholt Machine Co., Madison, Wisconsin, who use Ohio Knife bedways exclusively on their ram and saddle type Turret Lathes, made the above dramatic test for one of their customers. RESULT—another sale of a famous Gisholt Turret Lathe.

This super uniform hardness on the wear surfaces to a depth of 3/16" (64-66 Rockwell "C") is the reason why more and more OK ways, gibs, races, etc., are being specified on new equipment and used as replacements where former parts have failed. OK ways are practically wear proof assuring constant accuracy throughout the life of your machine. Enjoy with many prominent machine tool builders and users, the long wearing, supreme accuracy, super hardness of OK ways. Many sizes, shapes, etc., available, or made to your specifications.

OK wear strips are now available in welded Ampco bronze.
(Reg. U. S. Pat. Office by Ampco Metal Inc.)

Manufacturers for the Metal Working Industry of:

SLITTER KNIVES • SHEAR BLADES • ROTARY SHEAR KNIVES
HARDENED SPACERS • HARDENED WAYS • GIBS
BALL RACES • BRONZE WAYS • WEAR STRIPS

Write for comprehensive Bulletin to Dept. B

GO WITH OHIO GREEN

THE OHIO KNIFE CO.

CINCINNATI 23, OHIO

FOR GREATER SAFETY

Greyhound Specified

VICKERS HYDRAULIC POWER STEERING

700* on 400 New Coaches

*Order has been increased to 700 buses

Always searching for ways to further increase passenger safety, Greyhound Lines selected Vickers Hydraulic Power Steering for the 400 new Model PD-4104 GM Coaches recently purchased. 700*

Vickers Hydraulic Power Steering prevents the possible loss of driver control when a vehicle is forced off the pavement onto a soft shoulder . . . or when a front tire blows out. Extra steering power and quick maneuverability are always available for emergency conditions.

The Vickers System absorbs all road shock and transmits it to the vehicle frame . . . there can be no kick-back at the steering wheel. The driver supplies only enough effort to slightly move a servo valve . . . fatigue is thus greatly reduced and the driver is more alert.

Only minor alterations are usually required to incorporate Vickers Hydraulic Power Steering in new and existing vehicle designs. For further information, ask for new Bulletin M-5104.

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER ROCKFORD • SEATTLE • TULSA • WASHINGTON • WORCESTER

VICKERS hydraulic POWER STEERING is Effortless Positive and Shockless

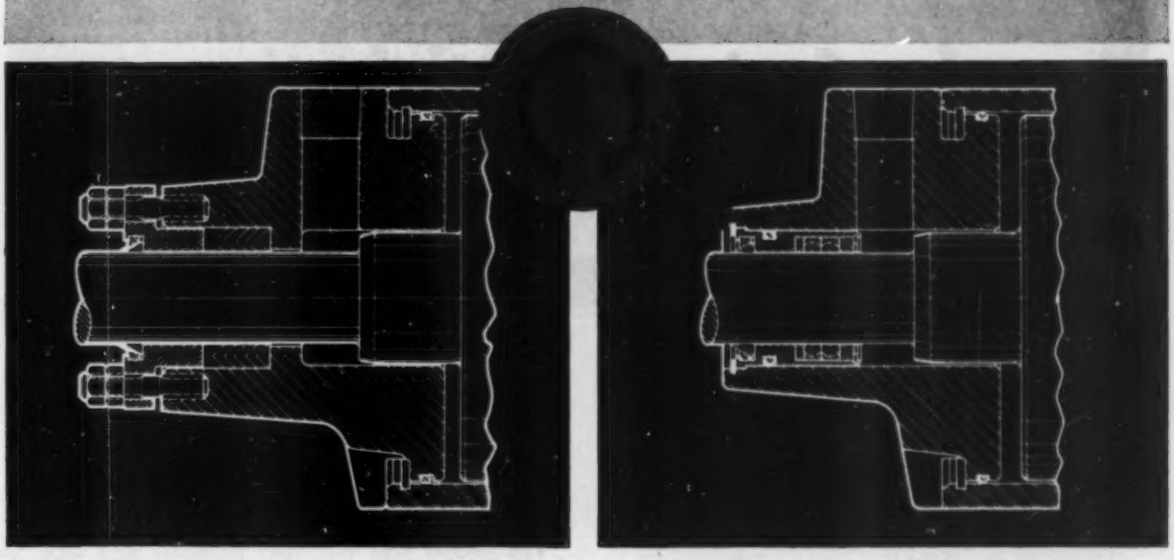
6478

Vickers Hydraulic Power Steering Booster does the actual work of steering

Engine-driven Vickers Vane Pump (with integral volume control and relief valves, and oil reservoir) supplies power for steering.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Waldes Truarc Ring Saves $2.84 Per Unit, Cuts Labor-Time and Materials in Hydraulic Packing Unit



OLD STYLE stuffing box required skilled worker to install packing rings one at a time, then adjust packing glands by trial and error. Disassembly was equally difficult, time-consuming and costly.

NEW Monopak Cartridge is smaller, lighter, streamlined and installed with one Truarc Retaining Ring. Disassembly and reassembly with new cartridge takes unskilled worker just 1 minute.

Hydraulic Accessories Company of Van Dyke, Michigan, uses a single Waldes Truarc Inverted Ring (internal series 5008) to hold Monopak Cartridge in cylinder head.

New design eliminates costly machining and saves 2⅛ lbs. of material. Re-design with Waldes Truarc Retaining Ring reduces stuffing box diameter from 3½" to 2⅞", and reduces length from 5⅞" to 4⅜". Allows savings in assembly, adjusting and testing.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS PER UNIT

MACHINE TIME SAVED:	
Chucking, facing and boring	$ .72
Drilling and tapping 3 holes	.18
Drilling and counterboring 3 holes	.12
Assembling, adjusting, testing	.90
MATERIAL SAVED:	
1⅛ lbs. cast iron	.30
⅛ lb. bronze	.23
3 studs	.36
3 nuts	.03
TOTAL	$2.84

Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool.

SEND FOR NEW CATALOG

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,362,947; 2,362,949; 2,416,052; 2,420,921; 2,420,941; 2,439,705; 2,441,846; 2,455,165; 2,483,300; 2,493,393; 2,497,802; 2,497,803; 2,497,906; 2,509,081 AND OTHER PATENTS PENDING

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print) PNOBS

Name.....

Title.....

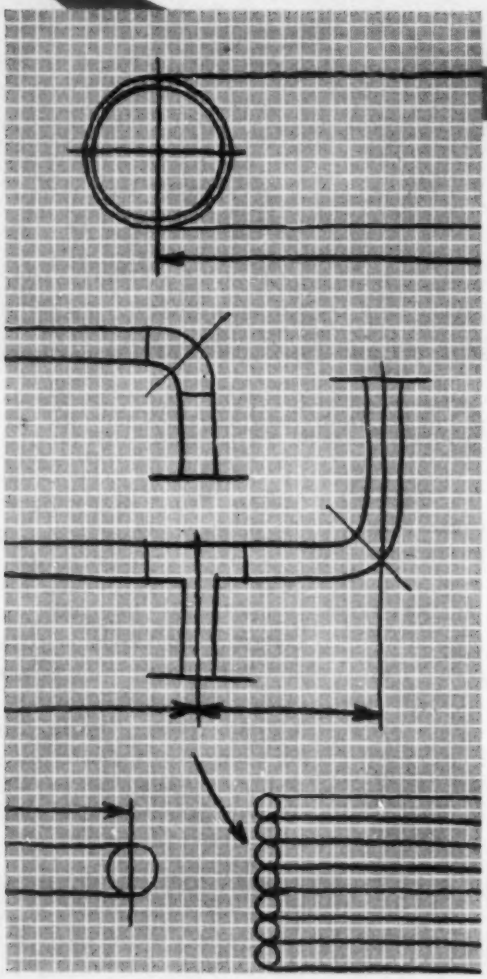
Company.....

Business Address.....

City..... Zone..... State.....

★

How to Design for Customer Satisfaction



The people who buy your products may look for many things such as efficiency, long life and eye appeal. Specifying Stainless for tubular parts may give them what they want.

But specifying Carpenter Stainless gives them more of it—and makes your production men happier, too. Helps step up your plant efficiency and profits.

Here's why. Carpenter Stainless is *different* . . . has many "extras" in working properties, corrosion resistance, tolerances, finishes . . . and we'd like to prove it to you.

One way we can do so is to ask you to call your nearest Carpenter distributor for documentary evidence. But you'll get quicker and more conclusive proof if you place your next tubing order with him. You'll discover that there *is* a difference in Stainless Tubing—and Carpenter makes it.

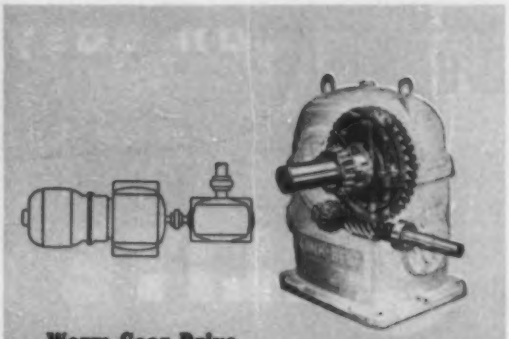
The Carpenter Steel Company, Alloy Tube Division, Union, N.J.
Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.
"CARSTEELCO"

Carpenter

STAINLESS TUBING & PIPE

• guaranteed on every shipment

LINK-BELT makes even your most complex speed reduction jobs *simple*

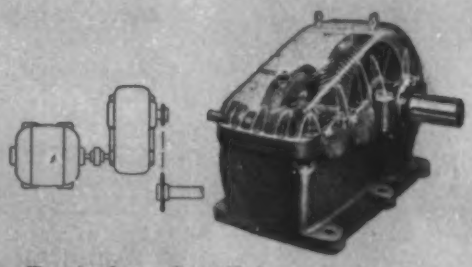


Worm Gear Drive

WORM GEAR and P.I.V. variable speed drives are shown direct-coupled. Link-Belt worm gear drives are available in 3.1:1 to 8000:1 reduction ratios — 1400 to 123,000 in. lbs. torque — 0.22 to 564 output shaft rpm. Ask for Book 2324A.

Gearmotor & Helical Gear Drive

GEARMOTOR is shown with roller chain drive. Link-Belt Helical Gear Drives, Gearmotors and Motogears are available in 6.2:1 to 292:1 reduction ratios — 1 to 30 hp — 6 to 280 output shaft rpm. Ask for Books 2247 and 2451.



Herringbone Gear Drive

HERRINGBONE GEAR DRIVE is shown connected by flexible coupling to motor and with roller chain takeoff. Link-Belt Herringbone Gear Drives are available in 2.84:1 to 326:1 ratios — 0.4 to 2480 hp — 2.2 to 623 output shaft rpm. Ask for Book 2519.

Get the proper drive combination that best meets your overall requirements from a broad line

ONLY Link-Belt can offer you such a broad selection of helical, herringbone and worm gear drives . . . plus the pre-engineered correlation of all its other power transmission equipment. This exclusive combination not only simplifies even the most complex problem — it actually cuts your costs. Here's how:

(1) You save on installation. Dimensions of all components — chains, sprockets, couplings, bearings — are correlated with the reducer's. There's no alignment problem . . . no need to exchange drawings with other suppliers.

(2) You save on operating costs. Power consumption is lower because overall efficiency is assured. And maintenance costs go down when you rely on quality-built Link-Belt equipment.

Let a Link-Belt representative help you figure the best combination for your speed reduction requirements. You'll find it pays to make the nearby Link-Belt sales office your power transmission headquarters.

LINK-BELT

ENCLOSED GEAR DRIVES

13,119-A

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities.

an easy way to cut your production costs

OILITE does it—

with FINISHED MACHINE PARTS

$.70

$.08

$1.30

$.07

Other Advantages Include:

- No investment in machine tools
- No costly tooling programs
- Releases skilled manpower to other jobs
- No material supply problems

FIELD ENGINEERS AND DEPOTS THROUGHOUT UNITED STATES AND CANADA

Oilite Products Include: Bearings, Finished Machine Parts, Cored and Solid Bars, Permanent Filters and Special Units.

READY FOR RUGGED DUTY

Maxi-Power Drive assembly for overseas cement mill. This unit, on a special base, has long input and output shafts supported by outboard bearings. The large spur pinion will drive a 20-foot, 18-inch face spur gear.

FOOTE BROS. MAXI-POWER DRIVES

With maximum load-carrying capacity for day-after-day service, Foote Bros. Maxi-Power Drives offer a ready solution for toughest speed reduction applications.

Sturdy, compact Maxi-Power Drives have precision-generated helical gearing — uniform load distribution across the entire tooth surface. Maximum performance is assured for all applications where rugged service is required.

These parallel shaft speed reducers are available in single, double or triple reductions. Ratios range up to 360 to 1 — capacities up to 1,550 horsepower — ideal for slow-speed requirements.

Foote Bros. also offers a complete line of foot or flange mounted drives for both horizontal and vertical applications, and Foote Bros.-Louis Allis Gearmotors, horizontal and vertical.

FOOTE BROS. Dust-Rated LIFETIME GEARING

This Trademark Stands for the Finest in Industrial Gearing

Line-O-Power Drives

Foote Bros.-Louis Allis Gearmotors

Hygrade Drives

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. W, 4545 South Western Boulevard, Chicago 9, Illinois
Please send Bulletin MPB containing full information on Foote Bros. Maxi-Power Drives.

Name.....

Company.....

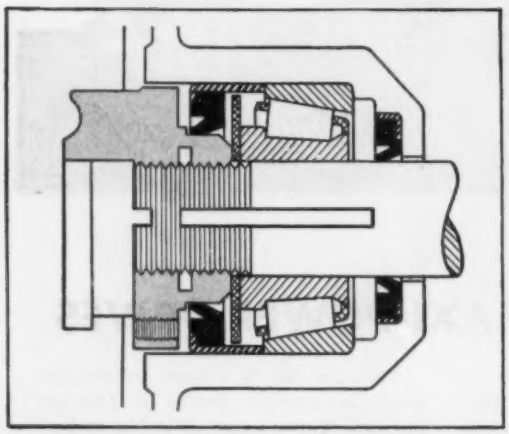
Address.....

City..... Zone..... State.....

New Continental Idler operates 1, 2, 3, or more years without relubrication . . .

WITH THE HELP OF KLOZURE*

Oil Seals



The new Continental UST idler uses two KLOZURE Oil Seals—one outboard and one inboard—to insure maximum bearing protection.

This UST factory-sealed belt conveyor idler, developed by The Continental Gin Company, was designed primarily to cut maintenance costs and insure a longer life for both the belt and idler assembly. Continental engineers wanted an idler that would operate satisfactorily without re-lubrication for one, two, three, or more years. That's why they chose a pre-lubricated sealed unit incorporating tapered roller bearings and dependable KLOZURE Oil Seals.

Garlock KLOZURES protect the bearings on Continental idlers by keeping the lubricant *in*, the dirt and moisture *out*. In addition, the KLOZURE assembly prolongs belt life by preventing the leakage of grease on to the belt.

For positive bearing protection specify KLOZURE Oil Seals for your machinery. KLOZURES are made in many models and in a complete range of sizes.

Write for Klozure Catalog No. 10.

Model 71-A Springless KLOZURE, the inboard seal

Model 71-A-7 Springless KLOZURE, the outboard seal

*REGISTERED TRADEMARK

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.
Branch Offices in Most Principal Cities

GARLOCK

PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS,
RUBBER EXPANSION JOINTS

By testing motors "twenty miles up"— G.E. gives you more for your motor dollar

This is an altitude chamber at General Electric's Specialty Motor plant in Fort Wayne, Indiana. Capable of simulating conditions at better than 100,000 feet above sea level, it enables G-E engineers to test fractional-horsepower aircraft motors . . . study the problems encountered in high altitude operation.

Similar tests are made for heat, cold, vibration, acceleration, etc., each resulting in improved engineering "know-how" . . . the "know-how" that helps to build a better quality fractional-horsepower motor for hundreds of different applications.

Whenever you need motors, remember General Electric's engineering skill and reputation for both quality and completeness of line. And if you cannot find a motor to exactly solve your own special problem, G.E. can design and build the G-E Specialty Motor that will.

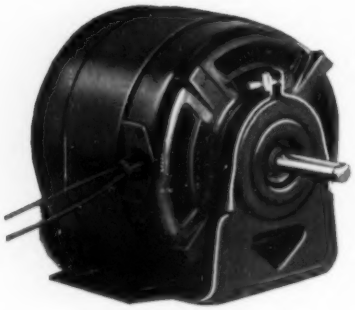
Turn the page for some examples of Specialty Equipment that may help you solve your problems. For complete information on G-E Specialty Motors, contact your nearby G-E Apparatus Sales Office.

You can put your confidence in—

GENERAL ELECTRIC

Here are 6 Examples of G-E Specialty Motor Products Built to suit your requirements

3 SHADED POLE MOTORS



Room coolers, refrigeration condenser fans, unit heaters, all small fans and blowers . . . have unique motorization requirements and G-E Shaded Pole Motors are designed especially for these requirements. Another example of how G-E Specialty Motors are designed for your special problems.

FEATURES . . . open or totally enclosed . . . 60/50 cycles, 1.5 watts to 1/10 hp . . . horizontal or shaft-up mounting . . . quiet unit bearing construction . . . sealed-in lubrication system for long life . . . small compact design.

4 AMPLIDYNES

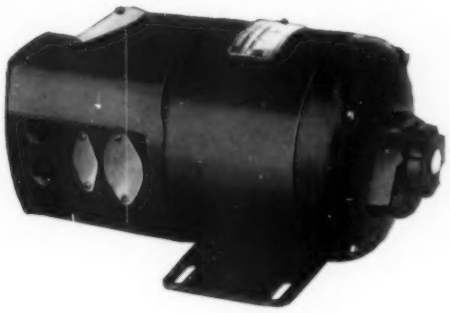
When you require fast, accurate positioning control . . . or control of torque, speed or tension . . . G-E Amplidynes are specifically designed for the tough applications.

FEATURES 500–1500 watts . . . dripproof . . . structural steel base. A generator with an extremely fast speed of response, pre-lubricated ball bearings, and rugged industrial construction, this close coupled amplidyne motor-generator set is used throughout industry, from making steel and tires, to paper and cloth—wherever close process control is required.

The General Electric Specialty Motor Sub-Department located at Fort Wayne, Indiana has the engineering knowledge, research facilities, and manufacturing experience to handle the difficult problems . . . the design problems that you may have with your product.

Possibly you would like to check the speed of a piece of rotating equipment . . . you need accurate speed control . . . or you must convert 230 V d-c to 115 V, 60-cycle a-c . . . whatever your application problem . . . the Specialty Motor Sub-Department can help you. Contact your nearest General Electric Apparatus Sales Office for assistance.

1 DYNAMOTORS



Designed to provide a convenient method for converting d-c power to 60-cycle a-c power at commercial voltages, G-E Dynamotors are particularly effective for mobile communication and refrigeration equipment and many auxiliary devices. In areas served only by d-c, G-E Dynamotors provide a flexible solution for such problems as sign lighting, tape recording, and public address systems.

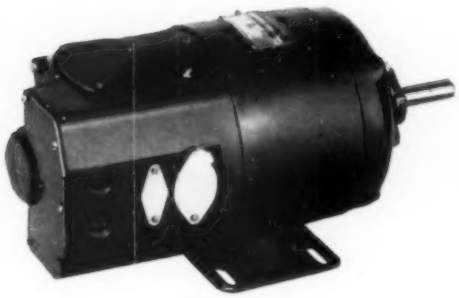
FEATURES Rubber mounted ball bearings for long life . . . 115 or 230 volt d-c input and also battery voltages . . . 115 volt 60-cycle single-phase output . . . Open (dripproof).

2 TACHOMETER GENERATORS

Do you need a method of recording or indicating speed of a small machine tool, or a large paper machine? You'll find that there is a G-E Tachometer Generator exactly suited to measure rotational speeds from 1 to 15,000 rpm, and all linear speeds which can be measured by rpm. Steel and aluminum mill drives, paper machines, hoisting and conveying equipment, and all types of machine tools are a few of many applications for Tachometer Generators.

FEATURES Totally enclosed . . . a-c and d-c . . . ball bearing construction . . . highly accurate . . . self-excited.

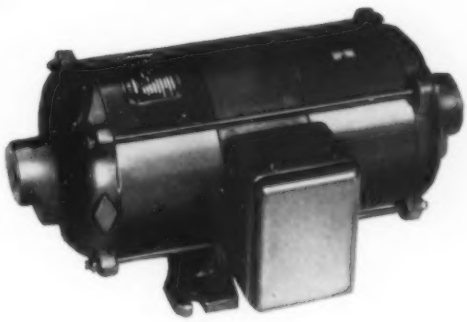
5 60-CYCLE GENERATORS



If you require a small, efficient source of alternating current where no a-c power is obtainable, a 60-cycle generator is the answer. These machines, suitable for belted or direct-coupled drives, are ideal portable power sources for communications equipment, field testing, small portable tools, and conversion from other frequencies (when suitable drive motors are available).

FEATURES rubber mounted ball bearings . . . 115 or 230 volt d-c input and battery voltages . . . 115 volts 60 cycle 200 to 500 volt-amps, single phase output . . . open (dripproof).

6 MOTOR-GENERATOR SETS



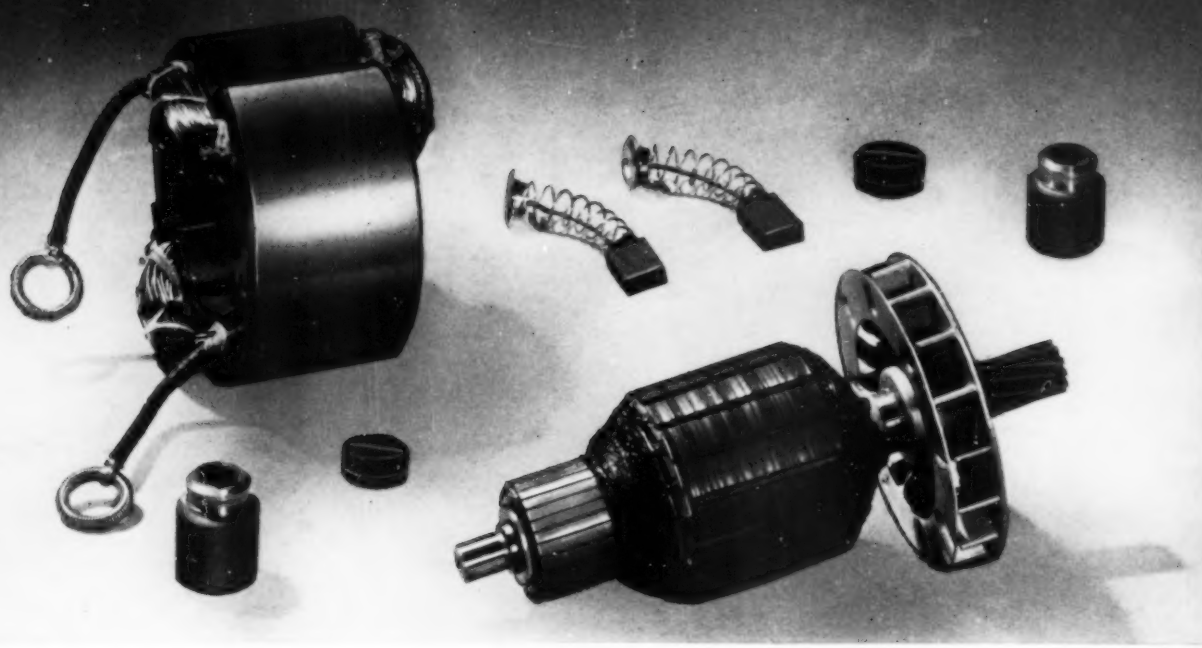
These sets are designed to fill your particular requirements for testing equipment such as transformers, relays, radio equipment, high-speed machine-tool drives, aircraft motors, and many auxiliary devices or wherever a source of d-c or 420-cycle power is required. 420-cycle Motor-Generator Sets are also suitable as a source of power to operate high-frequency machine tools.

FEATURES Fractional-horsepower . . . two unit . . . two bearing . . . 60 cycle to d-c or 60 cycle to 420 cycle . . . 250 to 2000 watts . . . continuous duty . . . 40 C rise . . . Open (dripproof).

You can put your confidence in—

GENERAL ELECTRIC

MADE TO MATCH YOUR HIGHEST STANDARDS



Use G-E series motor parts for rugged, reliable tools

Designed for heavy-duty service where momentary overload and no-load operation is experienced, General Electric heavy-duty series motor parts are completely reliable in the most rugged applications. These and the normal service parts are designed to precisely fit your particular requirements.

ENGINEERING KNOW-HOW. To improve your current model, or to be sure of the finest design possible for a new one, it will pay you to take your design problems to a G-E Motor Application Engineer. His experience can help you make profitable reductions in size, weight, and cost, as well as improve tool performance . . . appearance . . . and service life.

GEAR DESIGNING. Because gearing is often an integral part of a motor application problem, G.E. maintains a gear design group staffed by experts in the field of fine-pitched gearing. They co-ordinate their work with the motor application engineers to give you the best combination possible of motors and mechanical parts—the best portable tool you can build.

The quality and dependability of G-E Series Motor Parts, and the experience of G-E Application Engineers can combine to solve your design problems. Find out about them. See your nearest General Electric Apparatus Sales Office, or write for Booklet GEA-5665, Sec. 704-7, General Electric Co., Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

DESIGNING WITH ALUMINUM

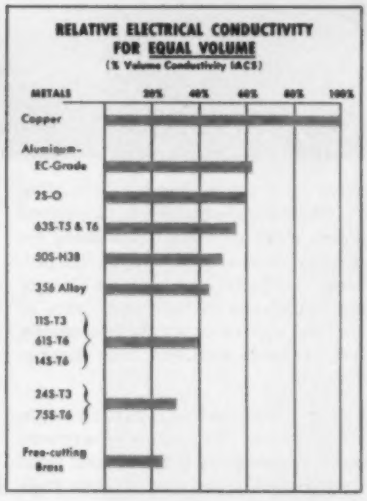
This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

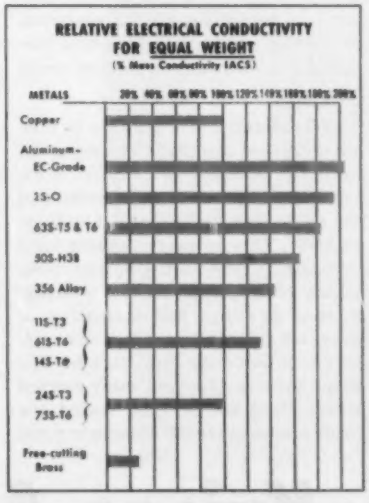
NO. 3 ELECTRICAL CHARACTERISTICS

HIGH CONDUCTIVITY-WEIGHT RATIO OF ALUMINUM ALLOYS USEFUL IN VARIED ELECTRICAL APPLICATIONS

USEFULNESS of a material for electrical applications depends substantially on such considerations as cost, availability, strength, weight, workability, and permanence as well as upon the electrical properties themselves. Aluminum ranks well in all factors, and as a result finds many electrical uses besides those in the field of power transmission and distribution, where it occupies a commanding position.

Per pound and per dollar, aluminum can deliver more electrical energy than any other material. Aluminum of EC (Electrical Conductor) grade, hard drawn (H19 temper), has a minimum conductivity of 60.97% of the International Annealed Copper Standard on the basis of *equal volume*, but its conductivity is *204% for equal weight*. In wire and cable design, volume conductivity is the factor commonly used. But in other electrical applications the mass conductivity may be more important.





Aluminum alloys also have good conductivity

The values above apply to metal of 99.45% minimum purity. But it is worth noting that practically all aluminum alloys have good electrical conductivity, especially on the basis of *equal weight*—a circumstance which may well be utilized advantageously in the design and manufacture of electrical equipment, fittings and parts having other requirements in addition to electrical conductivity.

Conductivity decreases with the addition of various alloying elements, but to a less degree than might be expected. The accompanying bar charts illustrate the relative conductivity of a number of widely used alloys on both the volume and weight bases. While they do not imply specific recommendations for electrical applications, the charts show graphically that on a comparative basis most commercial alloys of aluminum possess good electrical properties.

The alloys charted include representative non-heat-treatable and heat-treatable types of wrought and casting alloys, and all standard forms of aluminum mill products—sheet, plate, rod, bar, wire, forging stock, extrusions and casting ingot. Their availabilities are as follows:

ALLOY	
EC	Sheet, plate, wire, conductor, bus bar.
2S	Sheet, plate, rod, wire, forging stock, extrusions.
63S	Extrusions.
5CS	Sheet, plate.
355	Casting ingot.
11S	Rod, bar, wire.
61S	Sheet, plate, rod, wire, forging stock, extrusions.
14S	Sheet, plate, rod, wire, forging stock, extrusions.
24S	Sheet, plate, rod, bar, wire, extrusions.
75S	Sheet, plate, forging stock, extrusions.

These alloys include a range of tensile strengths up 83,000 psi for 75S-T6, the strongest commercially produced aluminum alloy, which on a *weight* basis has practically equal conductivity with copper. The tensile strengths of several other heat-treatable alloys are also greater than that of hard-drawn copper.

Also, a cable or bus bar of EC aluminum, having a tensile strength of 27,000 psi, will have a total breaking strength in tension close to that of a copper cable or bus of equivalent resistance because of the somewhat greater cross-sectional area required. An aluminum bus will have greater bending strength because of the increased section modulus.

The greater peripheral area of an EC aluminum conductor of equal resistance to a copper conductor means that it will dissipate more heat at a given temperature. This, combined with a lower inherent skin-effect, gives the aluminum conductor a current carrying capacity which varies from

PLEASE TURN TO NEXT PAGE ➡

78% to 84% (depending on size) of the same-size copper conductor.

Present applications suggest future uses

The progress made in recent years in successful electrical applications of aluminum indicates an accelerating rate of development. Thousands of fractional horsepower motors have been and are being produced with aluminum magnet wire stator windings. Some changes in manufacturing techniques were required, but no serious problems were met in actual practice, including aluminum-to-copper connections where they were required.

Similarly aluminum wire is being used, and giving good performance, in transformer windings and discharge lamp ballasts. Use of aluminum has even made it possible to build larger turbine driven generators than ever before because of its combination of light weight and good conductivity, permitting higher rotor speeds without exceeding safe centrifugal force limits.

Aluminum sheet is standard material today in the manufacture of electric light bulb bases and lamp sockets. The alloys generally used have a volume conductivity of 42% and 35%, respectively. Aluminum in these applications has better conductivity than brass, is more economical and is easily fabricated.

Cast aluminum is regularly used in the rotors of induction motors, with lower costs for both metal and fabrication. An important additional advantage is that cooling fans may be cast integrally with rotor bars and collector rings. Aluminum rod and bar (screw machine stock) are used for battery terminals, and similar applications.

Because it provides a high ratio of area to volume by being rolled to extremely fine gauges, aluminum foil is standard in capacitors. The surface area is generally increased further by etching the foil.

Connections for aluminum

Different types of connections and different techniques are employed with aluminum. Though not all problems have been solved yet, the important fact is that satisfactory connectors and methods for aluminum-to-aluminum and aluminum-to-copper connections are available and have proved themselves in practice. The use of welding to connect aluminum with copper shows much promise and is being exploited increasingly; it appears to perform satisfactorily in service despite the difference in the coefficients of thermal expansion for the two metals and provides excellent joint conductivity.

The oxide coating which forms on the surface of aluminum when exposed to air is insulating in nature and must be removed or penetrated when making a connection. Suitable contact and sealing pastes are available which assist in establishing a good electrical connection while at the same time preventing re-formation of a new oxide film.

(Incidentally, it is possible to take advantage of this oxide coating as an insulator. A thickness of .001" is capable of withstanding 1000 volts, and the oxide may be built up to as thick as .006". This property is being used in some current-limiting reactors, where it has been found that with aluminum windings the enameling of alternate layers of strands is unnecessary to provide the insulation needed to reduce skin-effect and eddy-current losses. Being stable when heated, the oxide may provide advantages in some applications over other normally used coverings such as organic coatings.)

Savings offer strong aluminum inducement

With its characteristics of less weight and substantially lower per pound cost, the savings in metal costs through the use of aluminum present an opportunity for substantial economies. In some cases, it is true, manufacturing costs may rise somewhat until techniques are developed, but seldom enough to wipe out the metal saving. On the other hand, economies in fabrication, handling and shipment will undoubtedly be achieved.

It is important also that the price of aluminum is relatively stable and that expanding aluminum production is steadily increasing its availability.

The broad advantages that aluminum offers in electrical applications are well worth investigating. Services of experienced Kaiser Aluminum engineers are available for consultation and assistance on your design and manufacturing problems. Call the nearest Kaiser Aluminum sales office or write Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

Kaiser Aluminum

see our catalog in PRODUCT DESIGN FILE or write for copy

setting the pace . . . in growth, quality and service

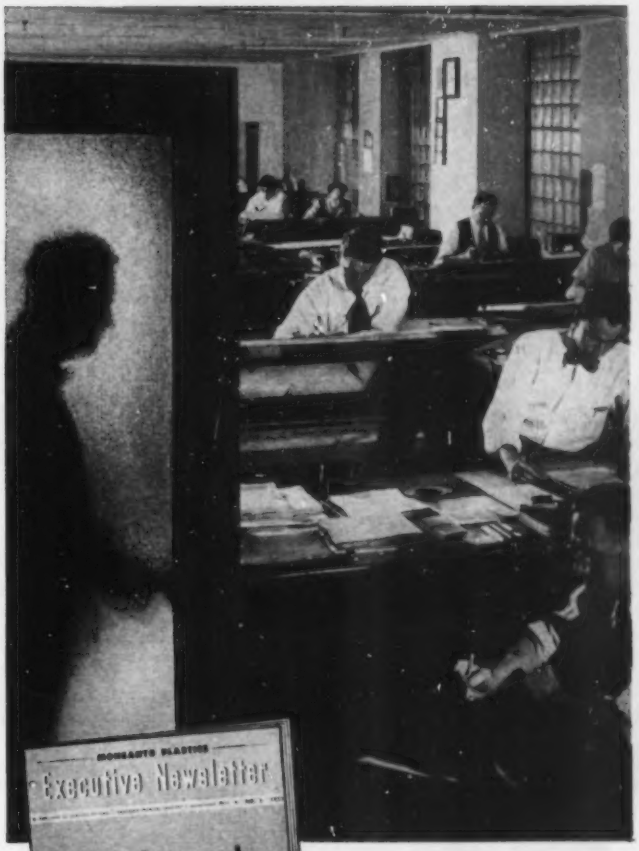
HOW TO OPEN THE DOOR TO PRODUCTION ECONOMY

New design approach explores production economies with plastics

A fresh approach to cost reduction, reported in a new Monsanto management study, lies in *designing* for production economy—with plastics. Thanks to this new trend in design thinking, manufacturers in many product fields are now cutting production costs by as much as 50 per cent.

Faster cycles . . . elimination of machining, painting, assembly and other finishing operations—made possible by plastics—are now prime considerations right at the conception of the product.

For the full story of how manufacturers are cutting costs with the new approach to design problems, send for your free copy of Monsanto's new management report. Just use the coupon below. Also—if you would like individual assistance with your materials problem, call on the Monsanto Technical Council—a board of experts in plastics, who will be glad to advise you on any questions related to plastics.



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Plastics Division, Room 2132, Springfield 2, Mass.
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"Oh, he never bothers to turn it on. He's just fascinated by the beauty of those Phillips Cross-Recessed-Head Screws."

PERFECTLY MATED! Only Phillips Drivers are perfectly mated to Phillips Screws. Look for the name Phillips on the shank.

BEAUTY is only one of many reasons why Phillips Screws help you build a better product. These screws set up tighter, resist vibration. They are distinctively designed to give maximum strength of head, maximum driver strength. What's more, they cut driving time up to 50%, eliminate driver skids and split screw heads. Whether you use Phillips Wood, Machine, Tapping Screws or "Sems", you save time, work, money.

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It pays to "shop around" before you make your power transmission or conveyor chain selections. Because, in order to get the most for your money, you need the right chain for your designs. For example, a precision-finished roller chain is ideal for high speed drives. But, roller chain is not the economical, efficient choice for slow speed, heavy-duty service. A heavy-duty steel or cast chain may be your answer here. That's why it will pay you to "shop" through the *complete* Chain Belt line before you make your choice. There's a size and type to fit any power transmission or conveyor need.

Don't be handicapped by relying on a supplier with a limited line to answer all your needs. It may cost you more... may handicap the expected performance of your machines.

Your Chain Belt Field Sales engineer will be happy to assist you in making the exact chain selection that best fits your requirements. He is not prejudiced by the limitations inherent in an incomplete chain line... can recommend the chain that will give you the service you want... at the lowest possible cost. For complete information or engineering assistance, mail the coupon.

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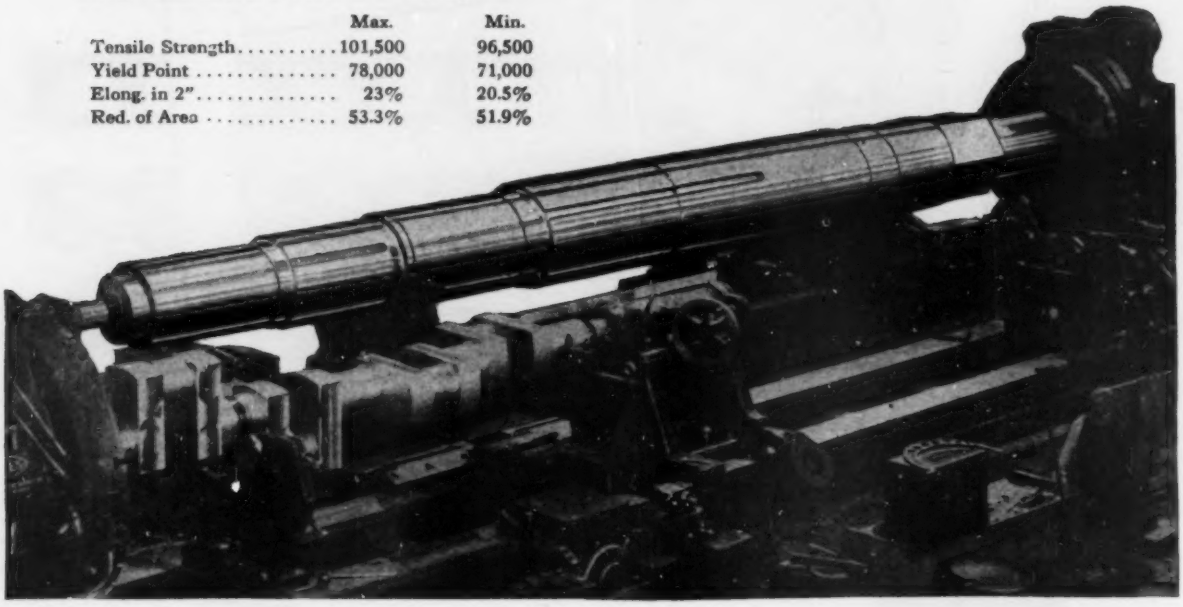
Company.....*Dept.*.....

Address.....

City.....*State*.....

NICKEL STEEL FORGING . . . a 58,950 lb. hoist drum shaft, 24" in diameter at its widest portion and 42' 9" long, produced by ERIE FORGE & STEEL CORP. Inspection revealed very fine grain. After being normalized and drawn, actual tensile tests in the longitudinal direction showed the following:

	Max.	Min.
Tensile Strength	101,500	96,500
Yield Point	78,000	71,000
Elong. in 2"	23%	20.5%
Red. of Area	53.3%	51.9%



How Erie Forge Obtains

Superior Properties in Large Forgings

To develop high tensile and elastic properties in large forgings, such as this giant shaft, by heat treatment is much more difficult than with smaller forgings.

For even though dimensions of a large piece may allow liquid quenching, section sizes involved ordinarily limit the cooling rates.

Experience shows that superior mechanical properties in large forgings depend largely on suitable alloy content . . .

Fundamentally, that is why the output of ERIE FORGE & STEEL CORPORATION of Erie, Pennsylvania, includes scores of large forgings produced from nickel alloyed steel.

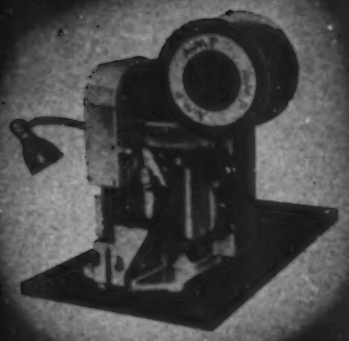
Nickel, either alone or in combination with other alloying elements, exerts highly beneficial influences. Its strengthening effect on ferrite is independent of carbon content or heat treatment of the steel, while its effectiveness in reducing the rate and temperature of the upper transformation, induces better response to the necessarily milder heat treatments used.

Nickel alloy steels may help you obtain peak performance from vital parts of *your* products or equipment. Send us the details of your problems for our suggestions. Write us now.

At the present time, nickel is available for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.



"Branded" so you KNOW it's right

AMP tools and terminals are members of a made-to-use-together team. They're made so that you can be *sure* you have a correctly installed termination. With AMP tools, the small DOT CODE "brand" gives an immediate check that the right color-matched tool has been used with the right color-matched terminal. This is just one more AMP control feature that insures the correct installation of your wire terminations day in, day out on the line—where it counts!

A-MP DOT CODE WIRE TERMINATION CONTROL

YOU CAN COUNT ON AMP

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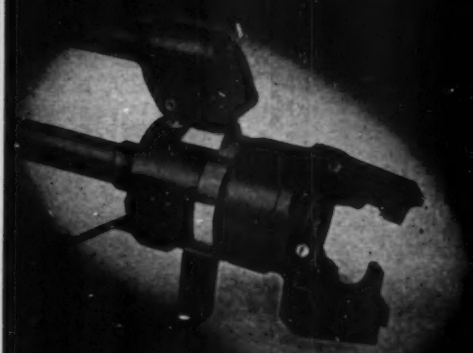

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2100 Paxton Street, Harrisburg, Pennsylvania

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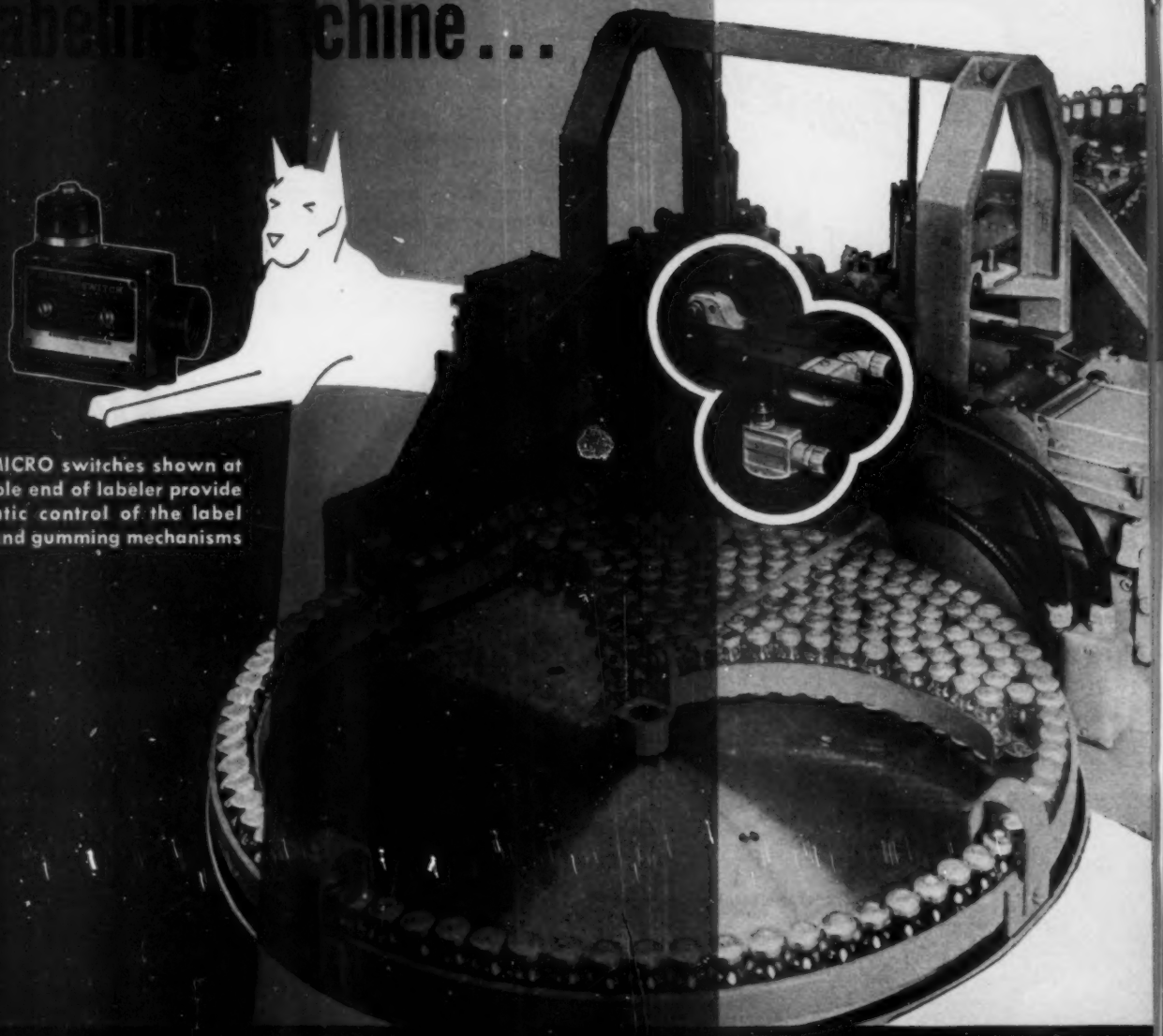
AMP Trade-Mark Reg. U.S. Pat. Off.

Trade-Mark

MICRO switches are ... prevent jamming ... this automatic ... labeling machine...



Three MICRO switches shown at feed table end of labeler provide automatic control of the label picker and gumming mechanisms

MICRO

MAKERS OF PRECISION SWITCHES

FREEPORT, ILLINOIS

A DIVISION OF

MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

Five MICRO switches, located at strategic points, provide electrically operated "watchdogs" for this World Model B Automatic Labeler of the Economic Machinery Company, Division of George J. Meyers Manufacturing Company.

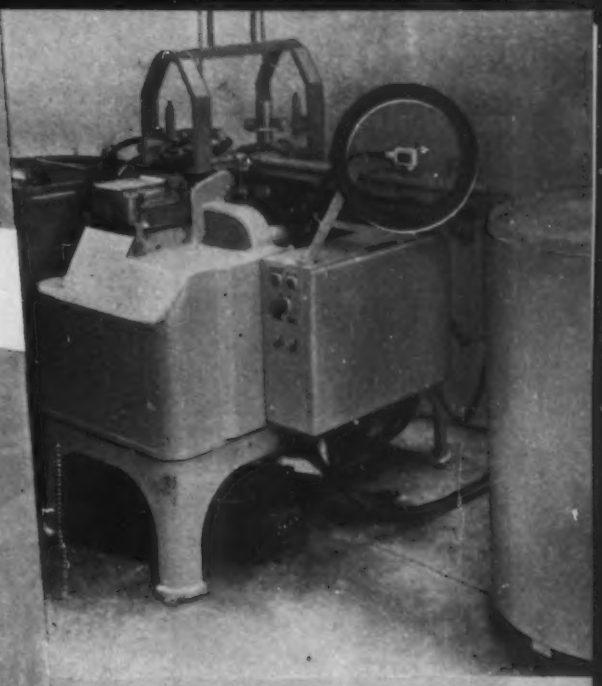
This ingenious machine is designed to label cylindrical vials or bottles at an adjustable speed range of from 90 to 180 bottles per minute. Automatic operation at such speeds depends on freedom from jamming because of free labels, broken glass or a bottle out of position.

Engineers of the Economic Machinery Company designed MICRO switches into the machine to serve as watchdogs at strategic points.

- **They prevent picking up a label unless there is a bottle in position to receive it.**
- **They stop the machine if a bottle is in position to be broken or to jam the machine.**
- **They control the label picking and gumming mechanisms.**

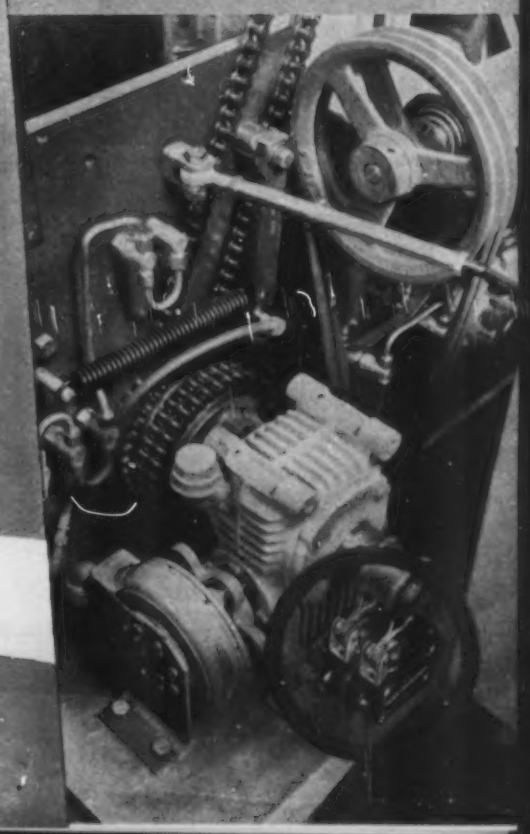
MICRO switches were selected as components of this automatic labeling machine because of their precise, dependable operation, their quick response to slight operating force, and sealed actuating plungers to keep out dirt and dust.

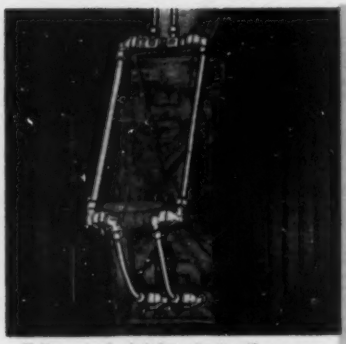
MICRO switches have proved to be "a principle of good design" in over 6000 specific applications for which switch types have been developed. One of them may give just the "lift" needed to your new product or to the redesign of an existing product. MICRO field engineers, experienced in every phase of industry, are available for advice and counsel to help you in the selection of a switch, or the development of a new switch if that is indicated. Call the nearest MICRO branch office.



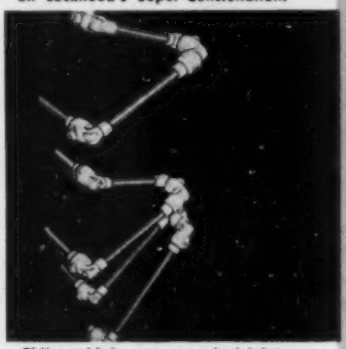
World Model B Automatic Labeler with accumulating tables for automatic infeed and discharge

These two roller arm-actuated MICRO switches control the solenoid which prevents the machine from jamming or labeling when a bottle is not in position

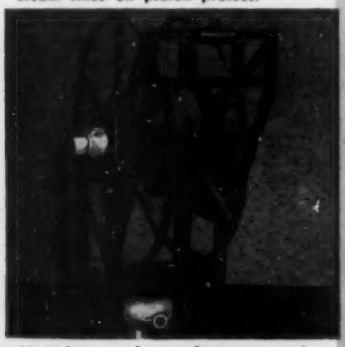




Chikson swivel joints in landing gear, braking and hydraulic control systems on Lockheed's Super-Constellation.



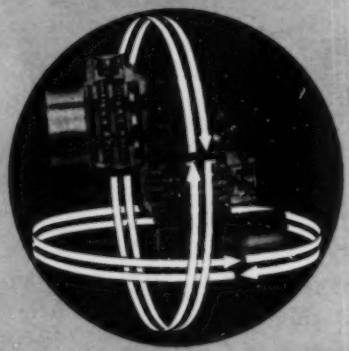
Chikson high-pressure swivel joints provide complete flexibility and safety in steam lines on platen presses.



Most hose reel manufacturers employ Chikson swivels for pressure and vacuum tight connections with low torque.

Colorado School of Mines turned to Chikson swivel joints for air and hydraulic lines on shale mining equipment.

CHIKSAN



THE NEW TOOL OF ORIGINAL EQUIPMENT MANUFACTURERS

Now Modern Industry has a *New* Tool available in CHIKSAN Ball Bearing Swivel Joints. These revolutionary flexible joints turn with full 360° rotation in 1, 2, and 3 planes, handling air, hydraulics, fuels, oils, water and other fluids.

There are over 1,000 different types, styles and sizes for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 75° F. to a plus 500° F. Packing materials have been designed for each specific service.

Wherever unlimited flexibility is required in your research, design and engineering of new equipment for modern industry—CHIKSAN will help you find the solution.

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The Flow of Enterprise Relies on

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Ball-Bearing Swivel Joints

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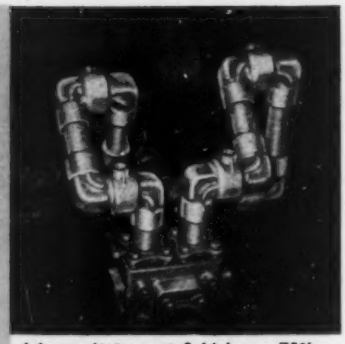
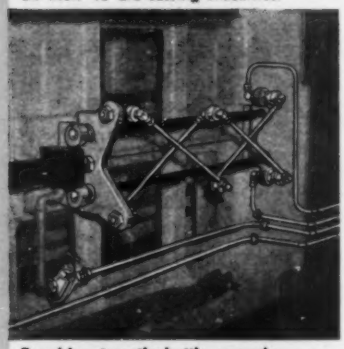
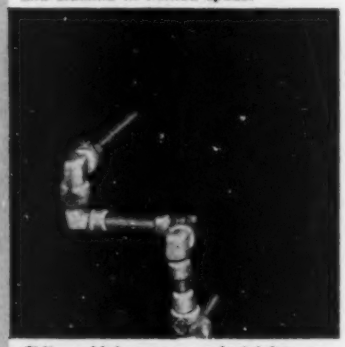


Johnson Motors cut fluid losses 75%—setting-up time 75% with Chikson joints on their 48 die-casting machines.



Ermold automatic bottle unpacker uses Chikson hydraulic joints for flexibility and stamina in limited space.



Chikson high-pressure swivel joints are installed for dependability and safety in injection molding equipment.

Chikson swivel joints are used on the coolant lines on the 160" plate mill in U. S. Steel's Homestead Works.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 28, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J

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N·A·X
HIGH-TENSILE STEEL

DECK HINGE

for

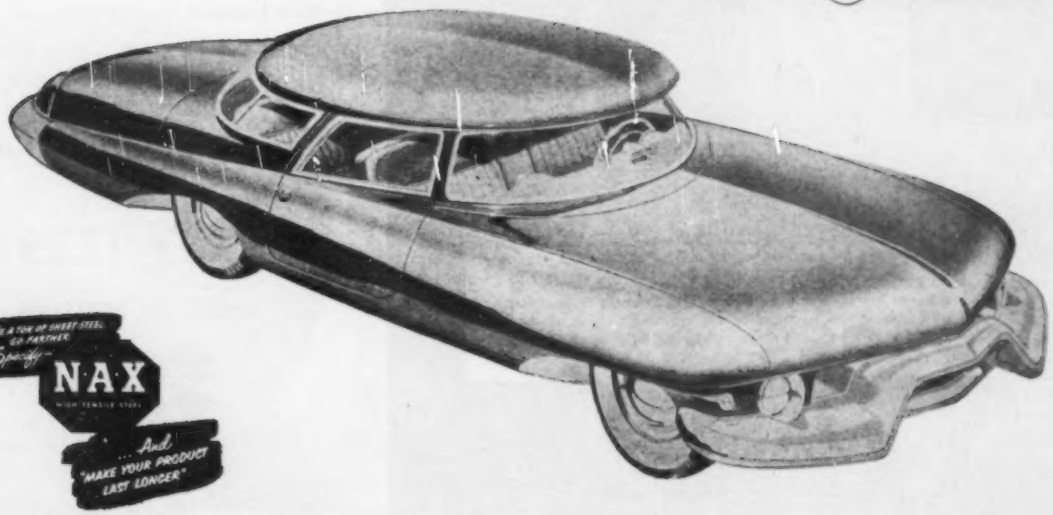
High Strength with Excellent Cold·Forming Properties

N-A-X HIGH-TENSILE, having 50% greater strength than mild carbon steel, permits the use of thinner sections —resulting in lighter weight of products. It is a low-alloy steel—possessing much greater resistance to corrosion than mild carbon steel, with either painted or unpainted surfaces. Combined with this characteristic, it has high fatigue and toughness values at normal and sub-zero temperatures and the abrasion resistance of a medium high carbon steel—resulting in longer life of products.

N-A-X HIGH-TENSILE, with its higher physical properties, can be readily formed into the most difficult stamped shapes, and its response to welding, by any method, is excellent. Due to its inherently fine grain and higher hardness, it can be ground and polished to a high degree of lustre at lower cost than can mild carbon steel.

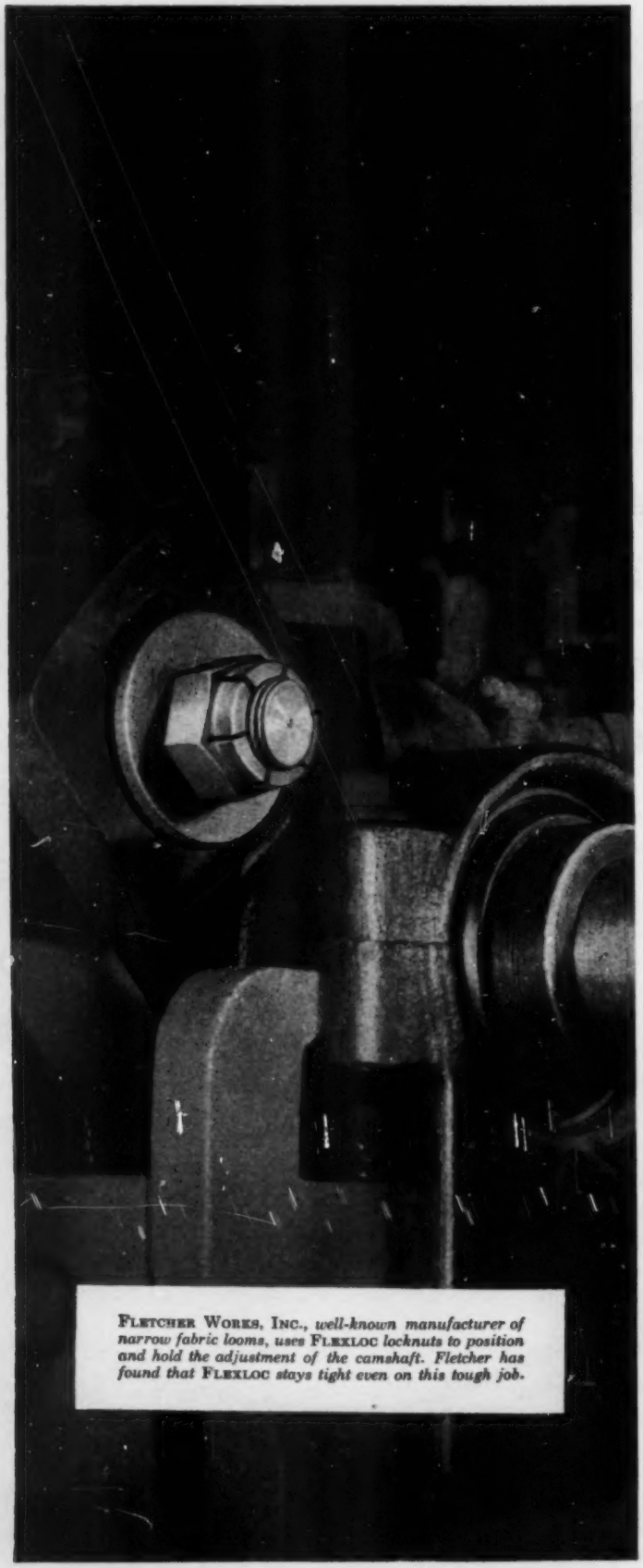
Your product can be made lighter in weight . . . to last longer . . . and in some cases be manufactured more economically, when made of N-A-X HIGH-TENSILE steel.

GREAT LAKES STEEL CORPORATION
N-A-X Alloy Division — Ecorse, Detroit 29, Mich.
NATIONAL STEEL CORPORATION



MAKES A TON OF SHEET STEEL GO FARTHER
Specify N·A·X
... And "MAKE YOUR PRODUCT LAST LONGER"

KEEP YOUR SCRAP MOVING TO YOUR DEALER



FLETCHER WORKS, INC., *well-known manufacturer of narrow fabric looms, uses* FLEXLOC *locknuts to position and hold the adjustment of the camshaft. Fletcher has found that* FLEXLOC *stays tight even on this tough job.*

How FLEXLOC locknuts reduce maintenance

FLEXLOCS reduce maintenance by staying where you put them. Once they are installed, you can forget them. Service and inspection periods can be stretched safely from days to weeks.

And FLEXLOCS eliminate complicated, time-consuming methods of locking threaded fasteners. They offer faster, simpler application, and safer, more dependable locking than plain nuts and lockwashers, castellated nuts and cotter pins, or nuts and jam nuts.

Use FLEXLOCS wherever you use an ordinary nut. These one piece, all metal locknuts—with nothing to assemble, come apart, lose or forget—won't work loose regardless of the vibration encountered. Yet they can be easily removed and used over and over again. FLEXLOCS are stop and lock nuts too. They don't have to seat to lock, and they stay put anywhere on a threaded member as soon as the locking threads are fully engaged.

You can get FLEXLOCS in a wide range of sizes in any quantity. Stocks are carried by leading industrial distributors everywhere. Write for literature and samples. SPS, Jenkintown 28, Pa.

FLEXLOC®

LOCKNUT DIVISION

SPS

JENKINTOWN PENNSYLVANIA

Our Fiftieth Year : A START FOR THE FUTURE

your HORSEPOWER sense!

Can you state the H.P. needed for these jobs?

CHECK ONE: ( )1/8-h.p. ( )1/6-h.p. ( )1/4-h.p. ( )1/3-h.p.

Right you are . . . the vast majority of refrigerators contain one-eighth h.p. motors. But did you know that more refrigerators are powered by Delco Motors than by any other make? It's a fact. Manufacturers appreciate Delco dependability!

CHECK ONE: ( )1/4-h.p. ( )1/3-h.p. ( )1/2-h.p. ( )3/4-h.p.

Right again! Most washing machines use one-third h.p. motors . . . and more and more manufacturers of washing machines are installing Delco Motors in their products. Delco's dynamically balanced rotor, and Delco's steel-backed babbitt bearing with cored oil wells mean long trouble-free service—always.

CHECK ONE: ( )1/6-h.p. ( )1/4-h.p. ( )1/3-h.p. ( )1/2-h.p. ( )3/4-h.p.

Correct . . . it depends on the size of blower required. So remember: Delco motors for blowers are available in all standard h.p. ratings . . . and Delco motors are favorites with furnace makers, due to their efficient, ultra-quiet operation.

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The best running mate your product can have!

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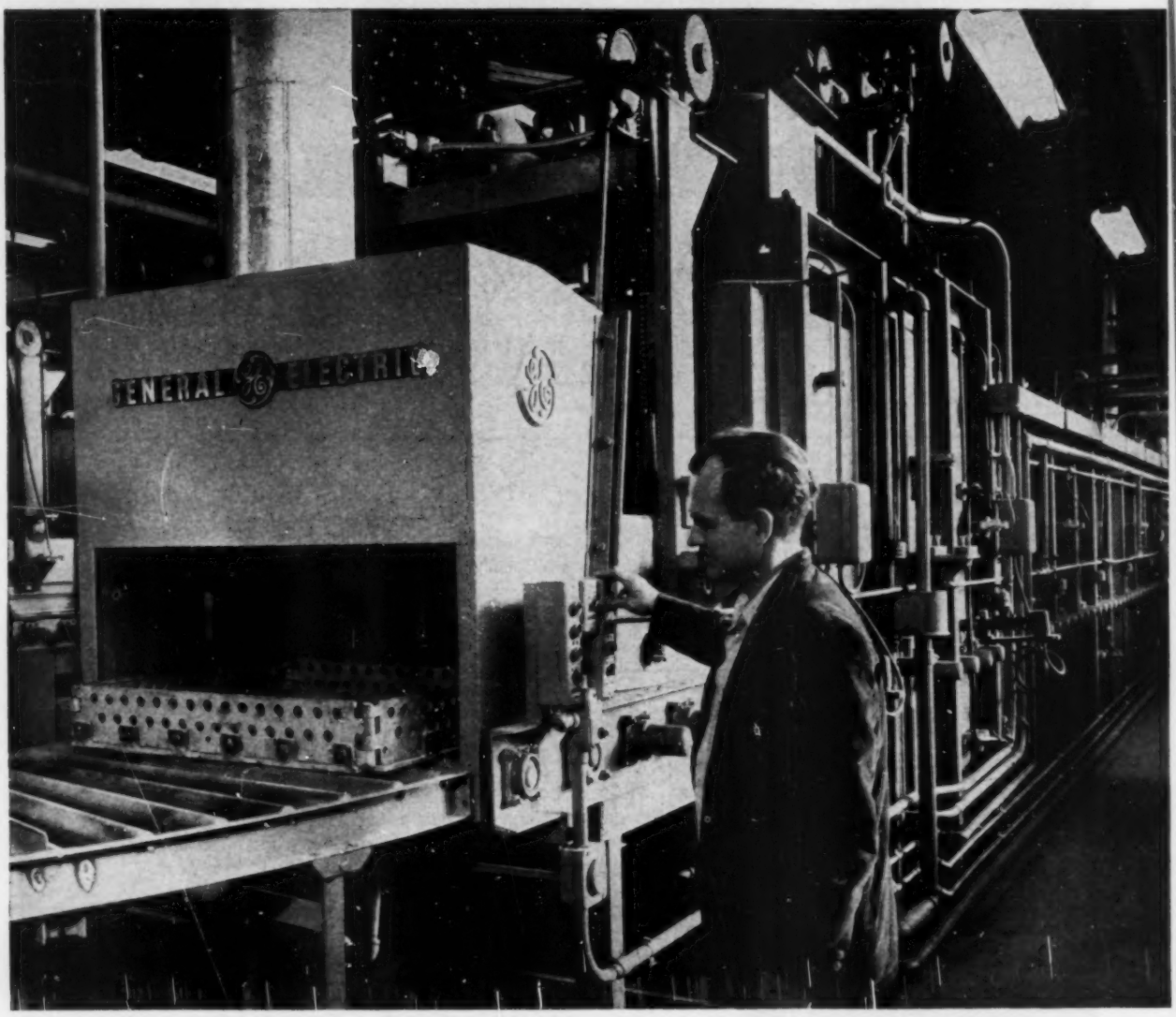
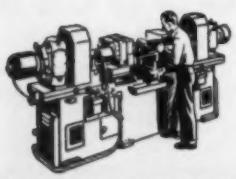
LINK-BELT ball and



Jet engine parts are heat-treated in General Electric roller-hearth furnaces at the Aviation Division of The Bingham-Herbrand Corporation, Freemont, Ohio. To counteract high temperatures, the Link-Belt ball bearing flanged blocks are water-cooled. Like other manufacturers of equipment that must operate efficiently under the toughest service conditions, GE utilizes various types of precision Link-Belt bearings.

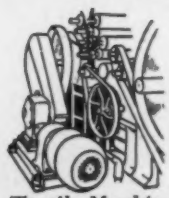
LINK-BELT ball and roller bearings



Metal Working Machinery

Farm Machinery

Construction Equipment



Textile Machines

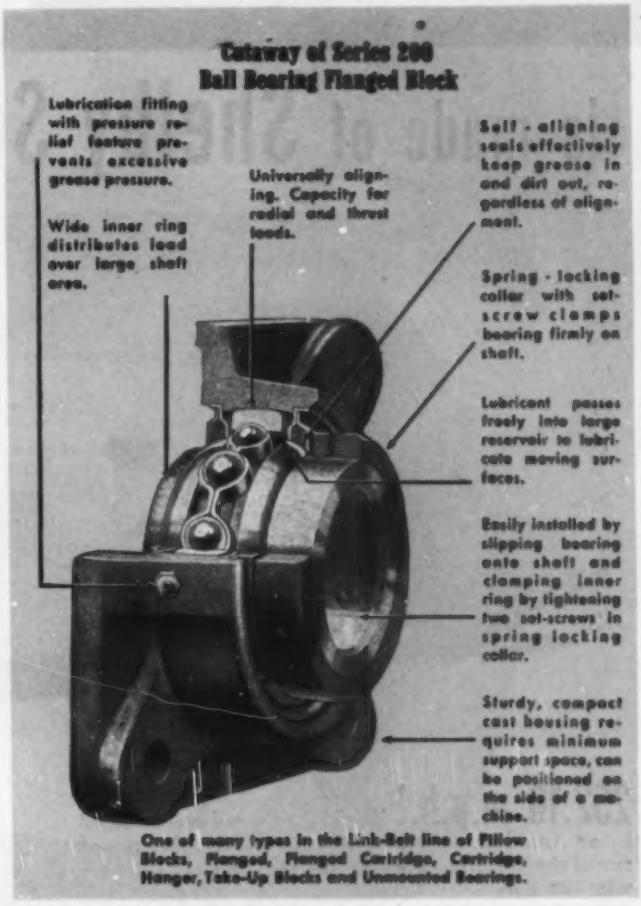
roller bearings

...keep company with America's hardest-working machines

WHERE loads are heaviest and operating conditions most severe—you can always rely on Link-Belt precision ball and roller bearings. That's why so many top equipment designers specify Link-Belt for their tough-job applications.

Thousands of installations have proved the dependability of Link-Belt bearings. Quality construction throughout—combined with precision manufacture—assures the ultimate in accuracy and long life.

There are Link-Belt ball or roller bearings to meet every industrial need. And there's a Link-Belt bearing engineer near you to help apply them to your particular requirements. You can also get all the facts from Data Book 2550.

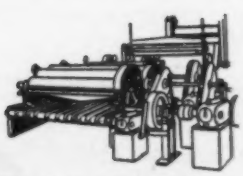

Cutaway of Series 200
Ball Bearing Flanged Block
Lubrication fitting with pressure relief feature prevents excessive grease pressure.
Wide inner ring distributes load over large shaft area.
Universally aligning. Capacity for radial and thrust loads.
Self-aligning seals effectively keep grease in and dirt out, regardless of alignment.
Spring-locking collar with set-screw clamps bearing firmly on shaft.
Lubricant passes freely into large reservoir to lubricate moving surfaces.
Easily installed by slipping bearing onto shaft and clamping inner ring by tightening two set-screws in spring locking collar.
Sturdy, compact cast housing requires minimum support space, can be positioned on the side of a machine.
One of many types in the Link-Belt line of Pillow Blocks, Flanged, Flanged Cartridge, Cartridge, Hanger, Take-Up Blocks and Unmounted Bearings.

LINK-BELT

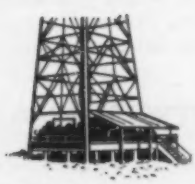
BALL and ROLLER BEARINGS

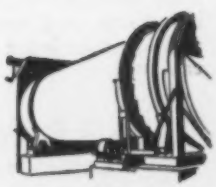
LINK-BELT COMPANY: Plants: Indianapolis, Chicago, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Scarboro, Ont. (Canada), Toronto (Canada), Elmira, Ont. (Canada), Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 13,273

smooth the path of power for all industry

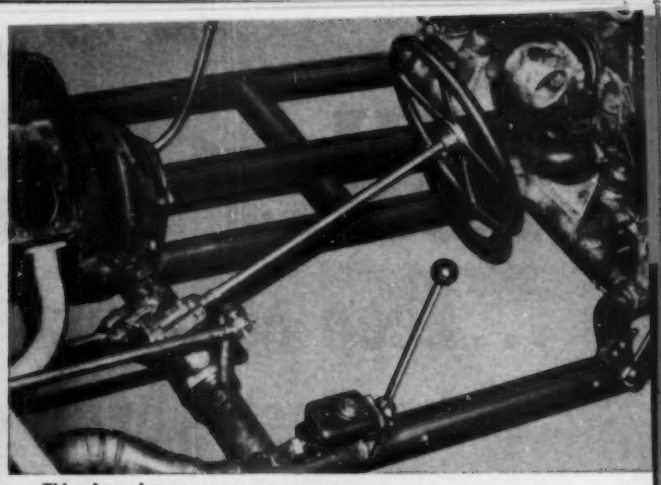

Pulp & Paper Machinery

Materials Handling Equipment


Oil Field Equipment

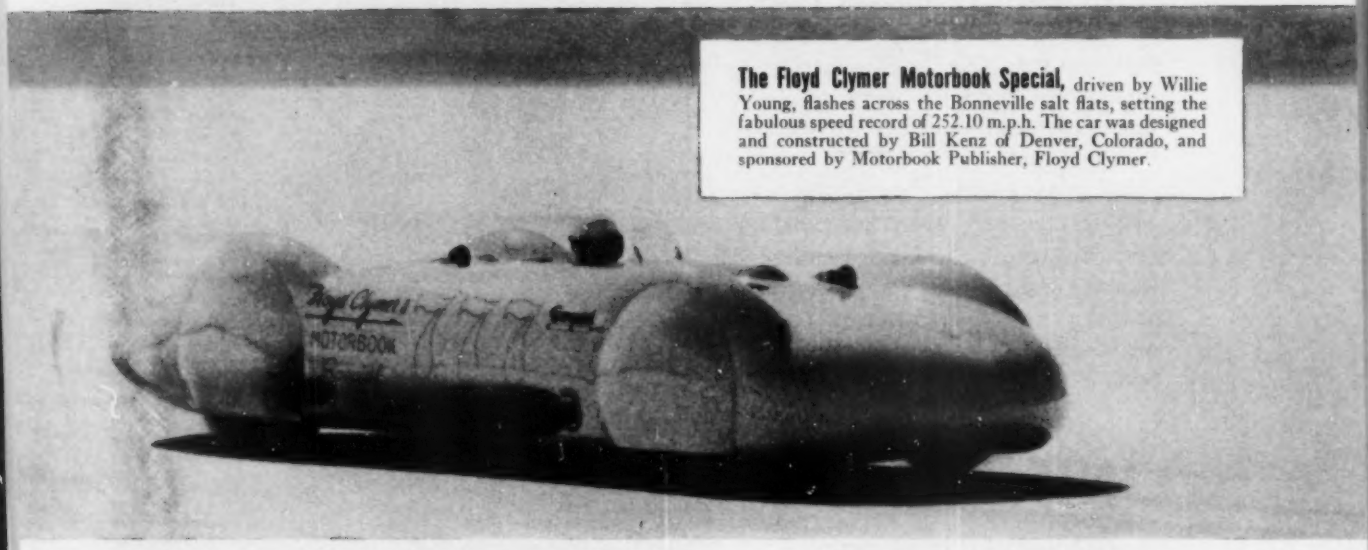

Processing Equipment

The frame of AMERICA'S FASTEST CAR



This view shows the rugged 2½" diameter Shelby Seamless Tube frame of the twin-engine speedster.

is made of Shelby Seamless Tubing



The Floyd Clymer Motorbook Special, driven by Willie Young, flashes across the Bonneville salt flats, setting the fabulous speed record of 252.10 m.p.h. The car was designed and constructed by Bill Kenz of Denver, Colorado, and sponsored by Motorbook Publisher, Floyd Clymer.

252.10 m.p.h.! The highest speed ever attained by an American automobile. That's the one-way record run of the Motorbook Special last year on Utah's Bonneville salt flats.

To reach this kind of speed and maintain it safely, a combination of power and strength—*with lightness*—is needed. Two 220 h.p. modified Ford engines supply the power. The frame is fabricated from Shelby Seamless Steel Tubing. Therein lies the strength—maximum strength with minimum weight that is basic in tubular steel construction. For such requirements, a tube is the strongest structural form you can buy.

Rugged, shock-absorbent Shelby Seamless Tubing combines to the highest degree the factors of strength, safety, and workability. It is uniform throughout, dimensionally accurate, easy to bend and shape. And it possesses excellent machining and superior welding qualities.

Shelby Seamless Mechanical Tubing is produced to exacting standards by the world's largest manufacturer of tubular steel products. It is available in a wide range of diameters, wall thicknesses, and steel analyses. You are welcome to call on our engineers any time. They will be glad to help you apply U·S·S Shelby to your specifications.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL

HAVE YOUR FASTENING METHODS

kept pace?

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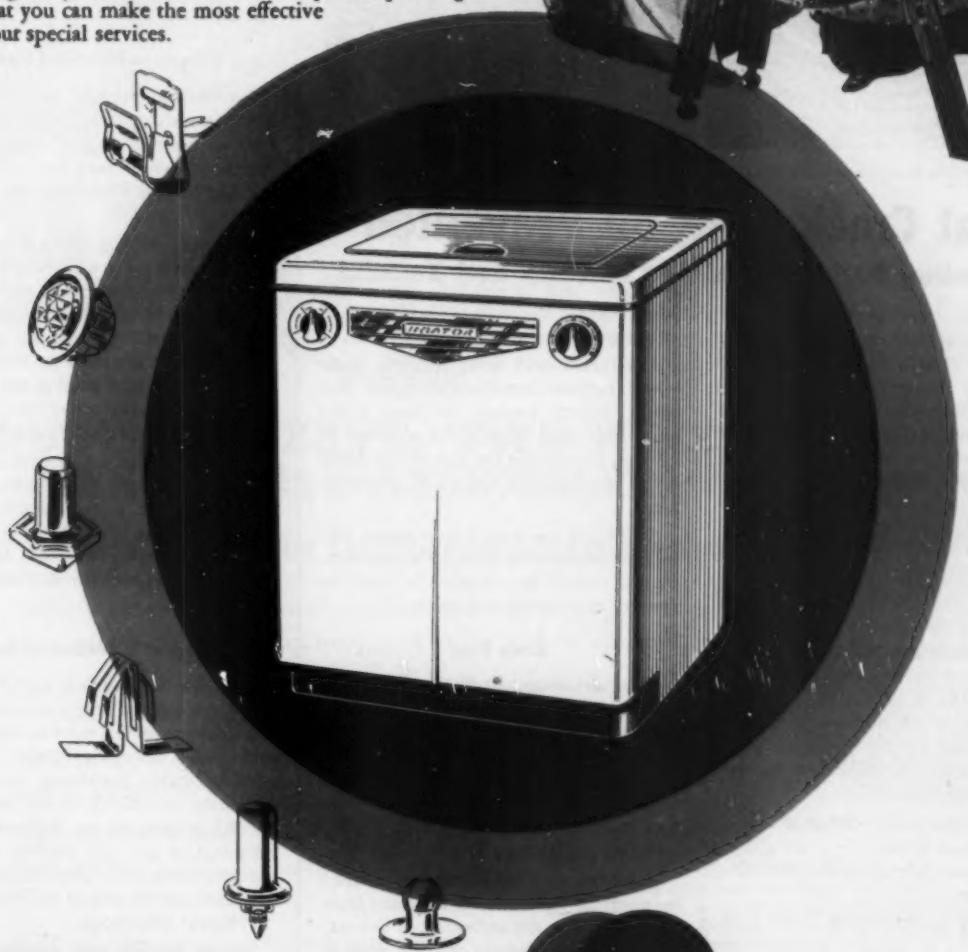
United-Carr offers you ★ Complete engineering and design service. ★ Complete facilities for volume production of specialized fasteners and allied devices. ★ Wide experience with the top manufacturers of appliances, automobiles, aircraft, electronic equipment, furniture. ★ The varied technical knowledge of all our divisions and subsidiary companies combined . . . to help you cut costs, speed assembly, improve product performance.

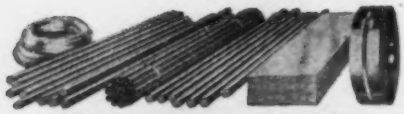
Call your nearest United-Carr field engineer *before* your new designs crystallize. It is in this all-important *planning* stage that you can make the most effective use of our special services.



UNITED-CARR **DOT** ***FASTENERS***

UNITED-CARR FASTENER CORP., CAMBRIDGE 42, MASS.

TAILOR-MADE IN VOLUME QUANTITIES

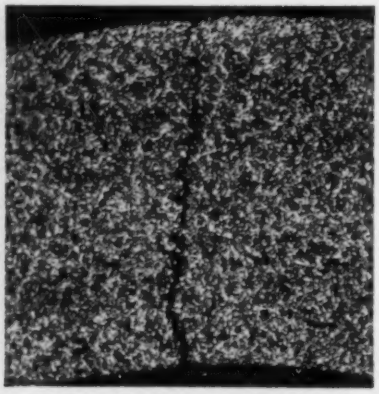


BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Heat crack resulting from deep drilling. Mag. 7x.



Transverse cross-section etch NH_4OH. Mag. 60x.

Heat Cracks Can Be Prevented

Overheating During Machining of Brass Rod Harmful

High heat, developed from severe machining and drilling operations on leaded brass rod, but not satisfactorily carried away by the coolant-lubricant, may cause serious hot breaks or cracks on screw machined pieces. Such cracks are intercrystalline in nature and are usually distinguished by darkening or heat tinting on the edges of the cracks.

Causes of Overheating

It is considered good practice to maintain the coolant-lubricant at a temperature of 90°F or lower. If it rises above this value, its cause should be investigated. Cutting oil has been known to heat up to 112°F or higher after 1½ hours of continuous operation. Hot oil is obviously not a good cooling medium and indicates trouble. Overheating can result from the following:

1. Dull, improperly designed tools and broken drills.
2. Insufficient lubrication at the cutting zone.
3. Excessive machining feeds and speeds.

It is well known that dull tools require greater pressures and develop higher friction heat.

Deep drilling is particularly heat forming because it is difficult to cool the drill directly. This is aggravated when operating with a broken drill which generates still greater friction.

Deep cuts and wide forming tools which remove considerable stock also create a large amount of heat. Sufficient side rake should be allowed to prevent burnishing the side of the metal being cut, another source of excessive heat.

Tool hardness is very important. The highest possible hardness without brittleness should be attained in order to prevent premature tool wear.

Keep Cool

Heat developed at the cutting zone should be dissipated rapidly by the coolant-lubricant. Insufficient cooling may be due to the fact that the stream of cooling liquid may be partially deflected by the chips curling above the tool, thereby preventing sufficient contact between coolant and cutting edges.

Faster cooling has been accomplished by spraying the coolant-lubricant from below to strike the underside of the cutting zone. The greater surface area of the coolant-lubricant spray particles is said to carry off the heat faster than the usual flooding from above. It also minimizes the tendency towards welding or the accumulation of deposits on the cutting edge of the tool.

When excessive heat is developed and cannot be removed quickly enough, it may be necessary to increase the cooling rate of the cutting fluid by increasing its volume.

Keeping both tool and work cool is the answer to rapid machining of hard, tough alloys like Duronze III (silicon aluminum bronze), which require more power and develop more heat than leaded brass rod.

Excessive Machine Speeds

Increasing machine speeds without corresponding modifications of the cooling procedure and coolant-lubricant composition may lead to overheating and possible cracking of machined pieces.

Ordinary cutting oils are capable of cooling work up to a certain machining speed. Beyond this point, the oil heats up. Increased cooling properties can sometimes be obtained by adding a percentage of kerosene or mineral seal oil. Changing to a good grade of water soluble fluid with better cooling properties than oil is sometimes helpful.

When high speed operation is the goal and the volume of work warrants it, the installation of a refrigerated central cooling system should be considered. Adequate cooling of tools and work means greater tool life and higher productivity.

Bridgeport's Technical Service

Modern engineering specifications call for a variety of alloys with special physical properties such as high tensile and yield strengths, great hardness, good corrosion resistance. Such materials may be difficult to machine unless special procedures are followed. Much information on the variety of screw machine alloys available and machining methods can be found in Bridgeport's "Technical Handbook."

Please consult our nearest district sales office in connection with your metal problems and requirements. For immediate deliveries, Bridgeport carries adequate stocks in its warehouses which serve the most active industrial centers. (128)

ANCHOR

DUCTILE-SLEEVE, TWO-WIRE BRAID HOSE ASSEMBLIES

for extra safety in high-pressure usage

Factory assembled to your specifications — you get just what you want — plus an extra margin of safety and dependability.

Exclusive, ductile-sleeve, swaged-on grip makes coupling virtually part of hose reinforcing wire — prevents blow-offs.

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REVOLUTIONARY
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SPLIT-FLANGE CLAMP
Positive leakproof connection without threaded joints. Bolt centers are located to distribute the forces evenly and prevent tilting of the clamp-halves. Easy to assemble with small automotive-type wrench.

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IF you're having steel wire trouble, we'd like to have the chance to help you. Our metallurgists are real experts at solving problems involving the use of manufacturers wire. Sometimes they can suggest the use of a different wire that saves time, or money—or both—for the manufacturer. Sometimes they can come up with a change in fabricating technique that results in a real cost reduction. And, if you're in difficulty because you need a special kind of manufacturers wire, our staff will work with you to develop a new wire that will meet your exact specifications.

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AMERFINE—*High-quality fine wire.*

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AMERLOY—*alloy heading wire.*

AMERTEMP—*heavy-duty oil-tempered wire.*

AMERHEAD—*uniform heading wire.*

AMERSTITCH—*extra-tough metal stitching wire.*

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UNITED STATES STEEL

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Versatile standard-design National Oil Seals save time and avoid production "log-jams"

You save engineering time, get faster delivery and minimize tooling costs when you utilize standard-design National Oil Seals. National offers over 1,000 such seals, including virtually all commonly used types in standard shaft and bore sizes.

One of the most widely used standard-design seals is the time-tested National 50,000 series seal (Fig. 1). This design has a precision-made steel outer case and an accurately spring-tensioned sealing member of leather treated by an exclusive National process. It is particularly suited to heavy duty applications where dust and dirt conditions are severe. These seals retain lubricant in their sealing member and can thus run "dry" for some time without damage. This same type of sealing member is available as a dual tandem, dual opposed or external seal (Fig. 2), or in combination with felt or springless leather auxiliary members.

Fig. 1. National 50,000 Leather Seal.

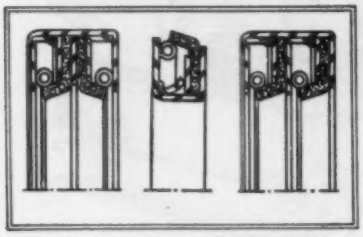

Fig. 2. L. to r., National 70,000, 80,000 and 90,000 Leather Seals.

The basic National 50,000 design is also offered as the National 50,000-S Syntech* seal (Fig. 3). This design has a spring-tensioned sealing member of National Syntech (synthetic rubber). This seal is in wide use throughout industry on automobiles, trucks and buses; electric motors, generators, pumps and other machinery. National Syntech is unaffected by most industrial fluids and is designed to operate over a wide range of temperatures and at shaft speeds up to 3,500 fpm. This design is available as a dual opposed, tandem or external seal, or in combination with felt or springless Syntech auxiliary members (Fig. 4).

Fig. 3. National 50,000-S Syntech Seal.

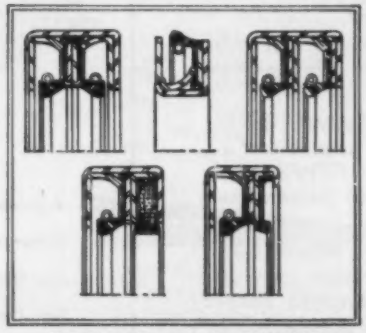

Fig. 4. Top, l. to r., National 70,000-S, 80,000-S, 90,000-S Syntech Seals. Bottom, l. to r., National 10,000-S Syntech-felt and National 20,000-S Syntech Seal.

Standard National designs also include many Syntech rubber-covered seals. Typical examples are shown in Fig. 5.

National Oil Seals shown here are suited to many different applications, from compact chain saws to giant earth-moving equipment. Next time you specify seals, why not talk to the National Oil Seal Engineer in your area? Chances are he can show you how a standard-design National seal can solve your problem.

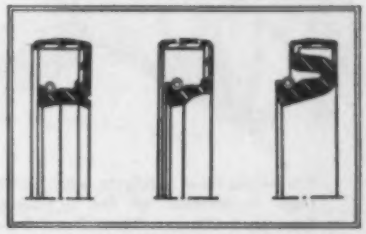

Fig. 5. L. to r., National 320,000, 350,000 and 370,000 Syntech Seals.

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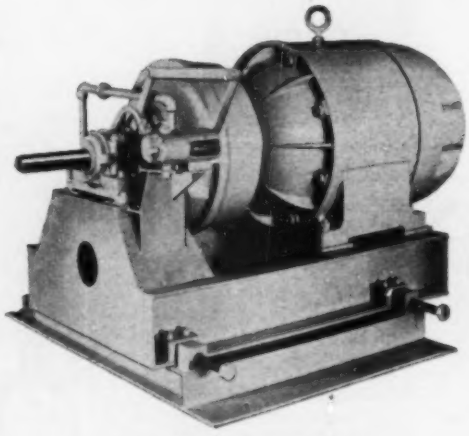

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**All standard lengths . . . diameters . . . wall thicknesses for the modern car*

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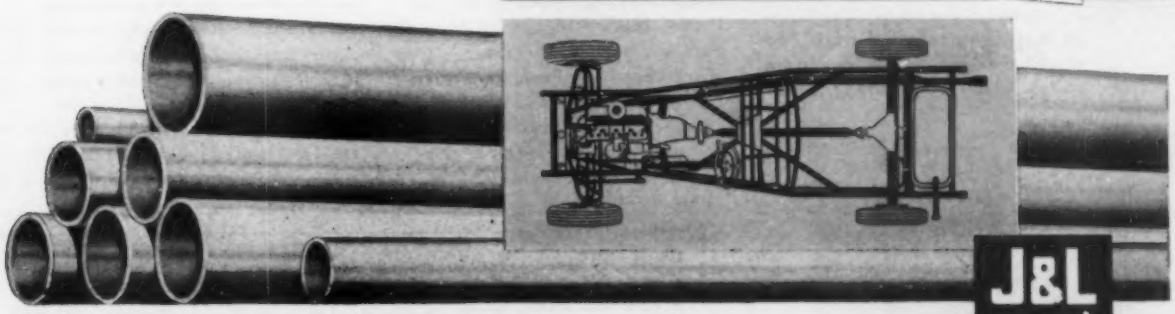

JONES & LAUGHLIN STEEL CORPORATION
PITTSBURGH 30, PA.

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Photo courtesy of Woodall Industries, Inc.

A stitch in metal saves *plenty!*

STITCHING with wire is a relatively new way of joining metal to metal, or metal to almost any other material. Since speeds up to 100 stitches a minute are possible . . . and since wire is economical . . . there are tremendous time-and-cost savings compared with other methods of fabrication.

Success of the whole idea hinges largely on special wire. For the wire must be *stiff* to penetrate metal. It has to be *strong*, up to 330,000 psi in tensile strength, to provide a lasting grip. Still it must be *ductile* to take tight 180° bends without cracking or breaking.

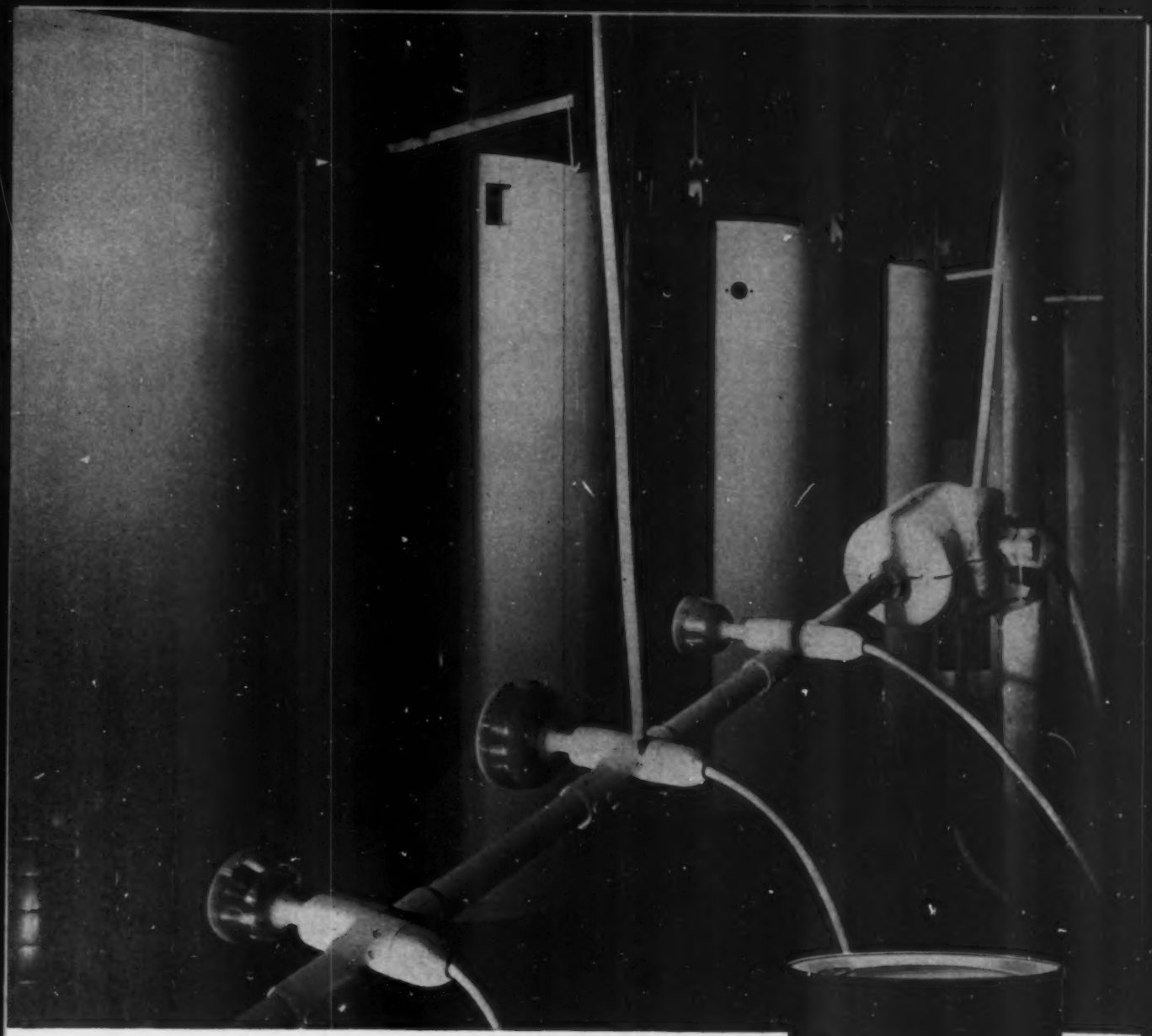
Here, at our Worcester Wire Works Division, this unusual wire is produced in several strengths, sizes and finishes to meet all metal stitching requirements perfectly! Here too, the skill and care for which Worcester Wire Works has long been known result in exceptional uniformity—a particularly great advantage for any user of machine-fed wire.

Do you have a problem involving wire? Perhaps, as in metal stitching, a new, specially developed wire is the answer. Maybe you need only some specialized engineering help on the use or fabrication of wire. In any case, Worcester Wire Works stands ready to serve you, to give you the advantage of engineering experience, special skills and techniques that have been over 30 years in the making. It's your standing invitation to out-of-the-ordinary, personalized service in wire.

NS NATIONAL-STANDARD NILES, MICHIGAN

DIVISIONS OF NATIONAL-STANDARD CO.

ATHENIA STEEL	*Clifton, N. J.*	Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD	*Niles, Mich.*	Tire Wire, Stainless, Fabricated Braids and Tape
REYNOLDS WIRE	*Dixon, Illinois*	Industrial Wire Cloth
WAGNER LITHO MACHINERY	*Jersey City, N. J.*	Metal Decorating Equipment
WORCESTER WIRE WORKS	*Worcester, Mass.*	Round and Shaped Steel Wire, Small Sizes



"MAGNETIC MAGIC" SAVES PAINT

Remember the old paint brush? By contrast, here is the latest method of applying paint—electrostatically.

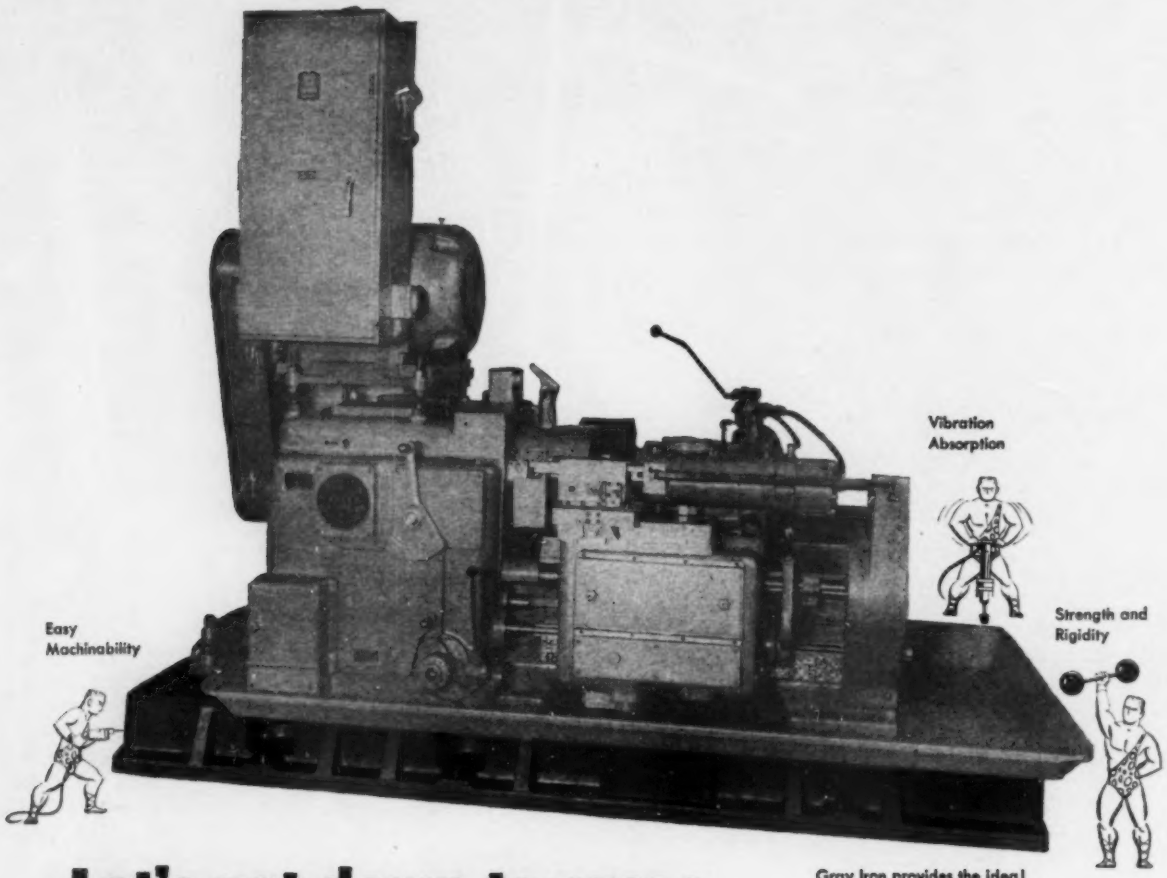
The cone-shaped heads above are spraying Glidden white Nubelite through a 100,000 volt field. The ionized particles are being attracted directly to the products, providing a smooth, durable finish. There's no overspray—no wasted paint!

Glidden Technical Service helped develop this installation for a leading manufacturer of electric water heaters. It's typical of Glidden's policy of helping manufacturers save paint while achieving the finest finishing results.

THE GLIDDEN COMPANY

INDUSTRIAL FINISHES DIVISION
11005 MADISON AVE. • CLEVELAND 2, OHIO

SALES OFFICES AND FACTORIES: San Francisco, Los Angeles, Chicago (Nubian Division—1855 North Leclaire Avenue), Minneapolis, New Orleans, St. Louis, Cleveland, Reading, Atlanta and Toronto.



Gray Iron provides the ideal combination of characteristics for the base of this automatic lathe.

Let's get down to cases ABOUT BASES!

GRAY IRON Characteristics Include:

- Castability
- Low Notch Sensitivity
- Heat Resistance
- Durability
- Machinability
- Rigidity
- Wear Resistance
- Corrosion Resistance
- Vibration Absorption
- Wide Strength Range

The manufacturer of this automatic lathe had previously used a fabricated steel base. To cut down delivery time and reduce costs, a switch was made to a cast Gray Iron base.

In the manufacturer's own words . . . "in addition to appreciable cost savings, delivery time to our machine shop is about one-eighth that of fabricated steel. Because of the rigidity inherent in the casting, we have a base which is easy to machine, absorbs vibration, and does the kind of a job our customers expect."

When you "get down to cases" about machine tool bases—or any other application requiring the unique combination of advantages listed at the left—be sure to investigate Gray Iron! Write for technical information on the many advantages of the Gray Iron casting process.

Make it Better with Gray Iron • **Second largest industry in the Metal-working field**

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG. CLEVELAND 14, OHIO

Spaulding

PRODUCTS for INDUSTRY provide STRENGTH

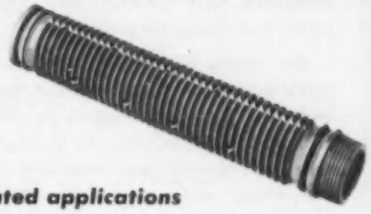
PLUS Good forming
Toughness
Lightness
Stiffness
Heat insulation

...as in protective headgear

PLUS Toughness
Inertness to oils, greases, waxes, and solvents
Clean punching

...as in gaskets and other machinery parts

PLUS Ease of machining to a glass-smooth surface
Absence of chipping, splintering, corroding, or staining
Toughness
Lightness



...as in textile and related applications

High mechanical strength is a required property of the basic material for many parts and components. It is seldom, if ever, the only property to be considered.

The various types and grades of Spaulding products offer strength in a wide range of combinations with other mechanical, electrical, and chemical properties.

If the material you seek should have strength plus other properties—or any difficult or unique property combination—consult the Spaulding Handbook or your nearest Spaulding Branch Sales Office.

SPAULDING FIBRE COMPANY, INC., TONAWANDA, N. Y., MAKERS AND FABRICATORS OF...

VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.

ARMITE: Thin Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.

SPAULDITE: (Laminated Phenolic Plastic) in sheets, rods, tubes and fabricated parts.

SPAULDO: Motor Insulation in sheets, rolls, coils, slot cells and other fabricated parts.

SPAULDING FIBRE BOARD: In sheets and fabricated parts.

SPAULDING T BOARD: A superior Transformer Board, in sheets and fabricated parts.

MATERIALS HANDLING EQUIPMENT: Factory trucks, Boxes, Barrels, Trays, etc.

SPAULDING FABRICATING FACILITIES

Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation to you.

SPAULDING BRANCH SALES OFFICES

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ST. LOUIS 5, MO. 34 North Brentwood Blvd.
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SPAULDING FIBRE CO., INC.
TONAWANDA, NEW YORK

Please send me by return mail my free copy of the new 40-page Spaulding Hand Book.

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Company

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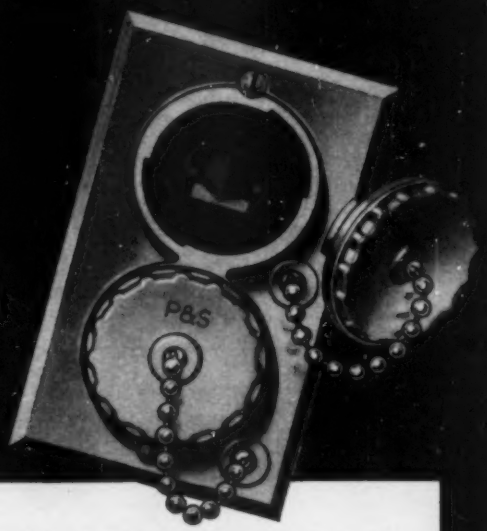
PE 6

DIE CASTING
eliminates four, expensive screw machine parts



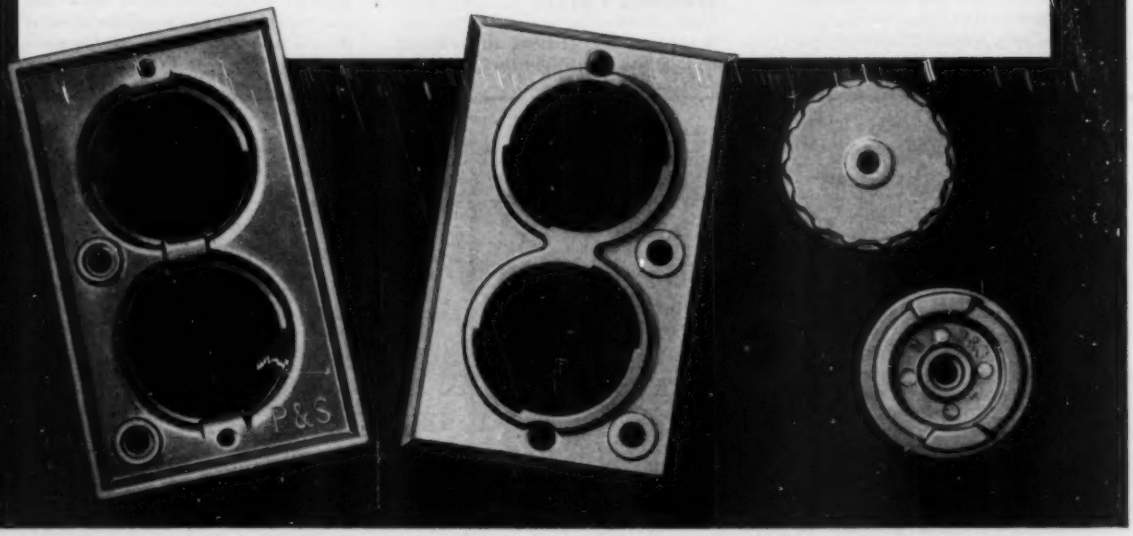
CASE HISTORIES FROM MT. VERNON FILES

When you're looking for ways to pare your production costs and boost your output on metal parts, investigate die casting.

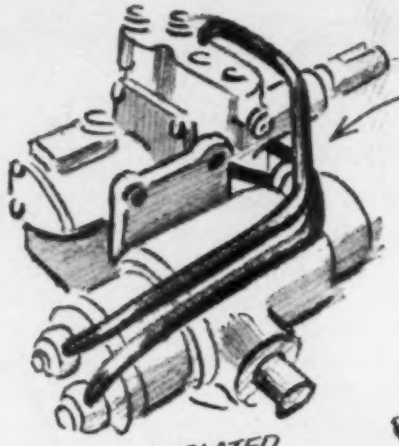
Die casting permits you to produce *intricate* metal parts or sections in a single operation. This reduces and often eliminates, the need for much machining and finishing. As a result, you save time and material. And frequently you can simplify design and lower weight without sacrificing strength or performance. Naturally, you get *better* products, *faster*, and at a *lower* unit cost.

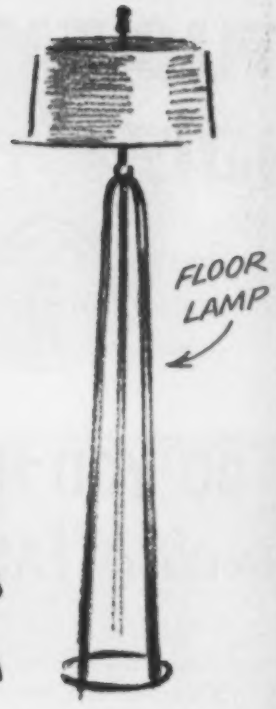
Pass & Seymour's new weatherproof electrical outlet clearly illustrates these advantages. Specifications for this outdoor outlet called for tight fitting, removable caps to make it weatherproof when not in use. Previously, P & S used threaded caps and housings which required four, expensive screw machined parts. Now, die casting has eliminated these parts—resulted in a much more satisfactory product. The new outlet has no threads to cross or catch. Its positive latching cap will not loosen, yet may be latched and unlatched with a simple turn. And its large die cast serrations provide a firmer grip.

The next time *you* have to select a manufacturing procedure remember these advantages of die casting—and consult us. We'll welcome the opportunity to show you how die casting can increase *your output*, improve *your products* and hold down *your production costs.*



FROM the Bundy Sketchbook
TO jog a designer's imagination





REMARKS You never know 'til you try. Bundyweld has helped lick hundreds of design, fabrication problems; might lick yours. It's the standard of tubing dependability in many industries. Then there's Bundy's unmatched fabrication facilities. Add our specialized engineering help, new custom-engineered packaging of orders.

WRITE today for Bundyweld catalog or for help in developing your tubing application ideas.

BUNDY TUBING CO., DETROIT 14, MICH.

Bundyweld Tubing

® DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

← NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • **Chattanooga 2, Tenn.:** Poirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • **Chicago 32, Ill.:** Lapham-Hickey Co., 3333 W. 47th Place • **Elizabeth, New Jersey:** A. B. Murray Co., Inc., Post Office Box 476 • **Philadelphia 3, Penn.:** Rutan & Co., 1717 Sansom St. • **San Francisco 10, Calif.:** Pacific Metals Co., Ltd., 3100 19th St. • **Seattle 4, Wash.:** Eagle Metals Co., 4755 First Ave. South **Toronto 5, Ontario, Canada:** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

DO YOU NEED *"Special"* FASTENERS

Why not use National's Special Product Service? It's sure to save you time and money in duplicating special fasteners you may now be using, or in designing and producing entirely new ones.

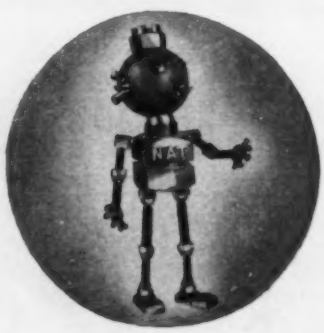
National engineers can help you find the solution to practically any fastener problem, and National's extensive production facilities with more than 3500 cold-heading and finishing units can produce your specials economically and in unlimited volume.

And, if you have small parts that may be adaptable to cold-heading production, you may find unusual cost-cutting possibilities by letting National's Special Product Service study them.

Send us your samples or specifications, or call the National representative nearest you. And remember . . . National makes the most complete line of standard fasteners and specialties such as lock nuts and self-locking bolts and screws.

Representatives in: Chicago, Cincinnati, Detroit, New York, Philadelphia, Kansas City, Denver, San Francisco and Seattle. Write or call direct to:

THE NATIONAL SCREW & MFG. COMPANY
Cleveland 4, Ohio
Pacific Coast: National Screw & Mfg. Co. of Cal.
3423 South Garfield Ave., Los Angeles 22, Cal.



National PRODUCTS

FASTENERS HODELL CHAINS CHESTER HOISTS

TWIN WELTERWEIGHTS (8 oz.) ONE-HANDEDLY BEAT OUT TWO-HANDED HEAVYWEIGHT

Or, in molding shop language, production went UP when single-cavity molds on two Fellows 5C-8 speed machines took over from two-cavity molding on one 16 oz. machine.

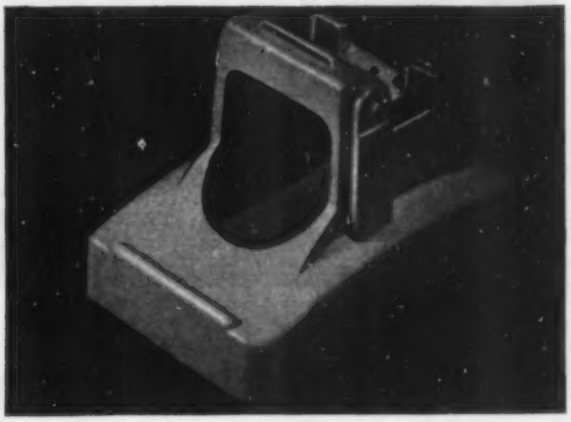
We'll get no argument that, as far as net speed per cycle goes, a Fellows Injection Molding Machine runs rings around the slower 'Big' machines. Nor is there much argument over the shop-profit importance of a-b-s-o-l-u-t-e s-p-e-e-d in pieces per hour.

Give any operator ability to turn out enough *more pieces* per man—per hour, and per dollar of total overhead, and the way is open to *produce and sell for profit.*

This color-styled telephone cover device isn't too easy to mold. The sections vary in thickness so cycling has to be accurately controlled to hold close-limit dimensions. Flow lines and sinks would cause immediate rejection. It's a job for a skillful molder—and the results prove that the right man was assigned the job in this case.

• Machines Speed Pays Off

It took imagination and an eye for the *ultimate profit dollar* to dare to re-make the molds to put the job on



speedy Fellows 5C-8s—two of them. But it paid off—as is to be expected!

The outstanding contribution which Fellows has made to injection molding, summed up in one word, is SPEED...and that means SUSTAINED SPEED, backed by mechanical reliability, automatic operation and *service* that sets Fellows in a class apart.

{ *If cost-cutting is your problem, get in touch with Fellows. The 3 oz. and 8 oz. Speed-Flo Injection Molding machines are the pace-setters of the industry. Write, wire or phone the nearest office.* }

Fellows

injection molding equipment

THE FELLOWS GEAR SHAPER COMPANY, Plastics Machine Division, Head Office and Export Department, Springfield, Vermont
Branch Offices: 323 Fisher Bldg., Detroit 2, Michigan • 5835 West North Avenue, Chicago 39, Illinois • 2206 Empire State Bldg., New York 1, N. Y.

PHOTO COURTESY OF SHELLMAR PRODUCTS CORP., MT. VERNON, OHIO

Making "picture packages" for Lipton's

Have you noticed the new trend in food packaging? Today, every food producer wants color in his packages—bright, rich color that will catch the customer's eye—and hold it!

One thing that helps to make these "picture packages" possible is a new method of lamination used to hold a transparent film (on which the colorful advertising matter is printed) to a protective foil (in which the food will be contained).

Many packagers rely on 3M adhesives to bond film and foil together Some, for example, use a 3M adhesive which is completely transparent when dry. What's more, it forms an immediate bond once applied. And its fast-drying property makes it possible to laminate packages on machines running at high speeds.

See what adhesives can do for you . . .

Making "picture packages" for Lipton's is another example of how 3M helps industry solve problems. For ideas on how 3M can help you, call in your 3M sales representative, or write for free, booklet describing many applications. Address: 3M, Dept. 48, 411 Piquette Ave., Detroit 2, Mich.

3M COMPANY

see our catalog in PRODUCT DESIGN FILE or write for copy

ADHESIVES•COATINGS•SEALERS

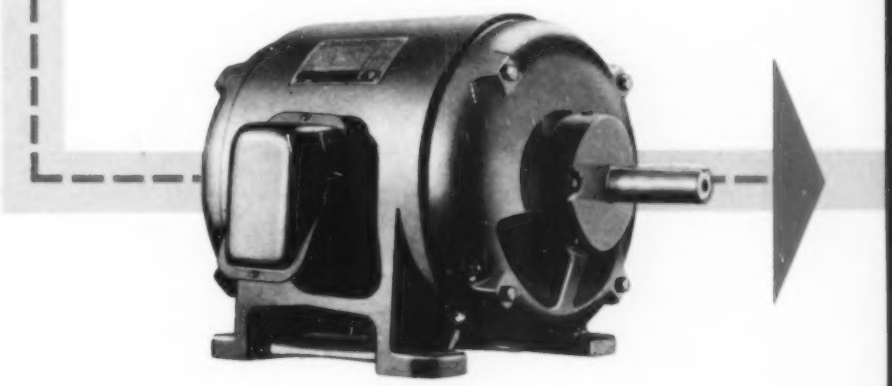
MINNESOTA MINING AND MANUFACTURING COMPANY

ADHESIVES AND COATINGS DIVISION • 411 Piquette Ave., Detroit 2, Michigan

GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N.Y. 17, N.Y. • CANADA: LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

Here Are Facts You Should Know About Electric Motor Bearings



A-4131

ALLIS-CHALMERS

Milwaukee 1, Wisconsin

AN IDEAL MOTOR BEARING would operate for indefinitely long periods under all types of conditions without requiring any attention whatever. However, in the opinion of our engineers, such a bearing and its attendant lubricant are not yet available on the commercial market. Consequently, bearings for many types of operations, particularly where overloading, extreme temperature ranges and chemical and dirt laden atmospheres are involved, require special lubricants or regular lubrication schedules.

Of course, bearings suitable for many kinds of operation under normal conditions can be built so that they do not require attention for very long periods — usually several years. Allis-Chalmers can supply sealed bearings in all frame sizes through 505 on short delivery and without extra cost for applications of this type.

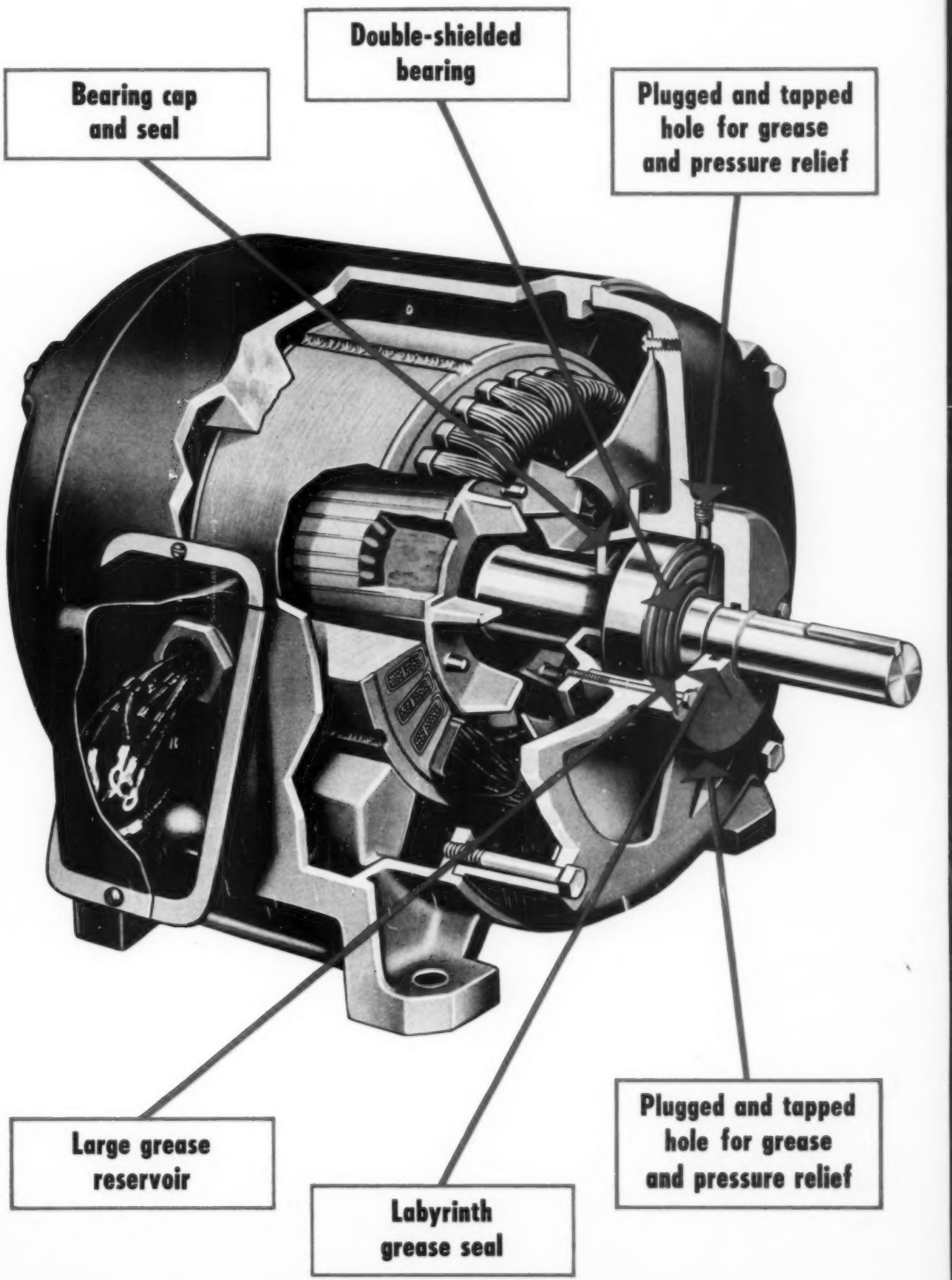
Which is the Best Design For Your Application?

We believe that the design used in standard Allis-Chalmers drip-proof, tefc and explosion-proof motors represents the best design for most industrial users.

The Allis-Chalmers standard design consists of a pre-lubricated, double-shielded bearing mounted in the end housing with a generous grease reservoir. Plugged and tapped holes are provided for grease and for pressure relief. Under normal operating conditions, this design will operate as long without attention as any other type of bearing in use today. But where difficult operating conditions make re-lubrication desirable, it can be done as part of the normal lubricating routine without dismantling the motor.

The large grease reservoir and shielded bearing design assure that grease lost from the bearing due to high operating temperatures or other causes will be replaced automatically.

For further information on bearing design and other outstanding features of all types and sizes of Allis-Chalmers motors, call your nearby Allis-Chalmers District Office.


Double-shielded bearing
Bearing cap and seal
Plugged and tapped hole for grease and pressure relief
Large grease reservoir
Labyrinth grease seal
Plugged and tapped hole for grease and pressure relief

Everything You Need . . .

from Power Line to Driven Shaft

Motor, Control, *Texrope* V-belt Drive . . . All from one reliable source

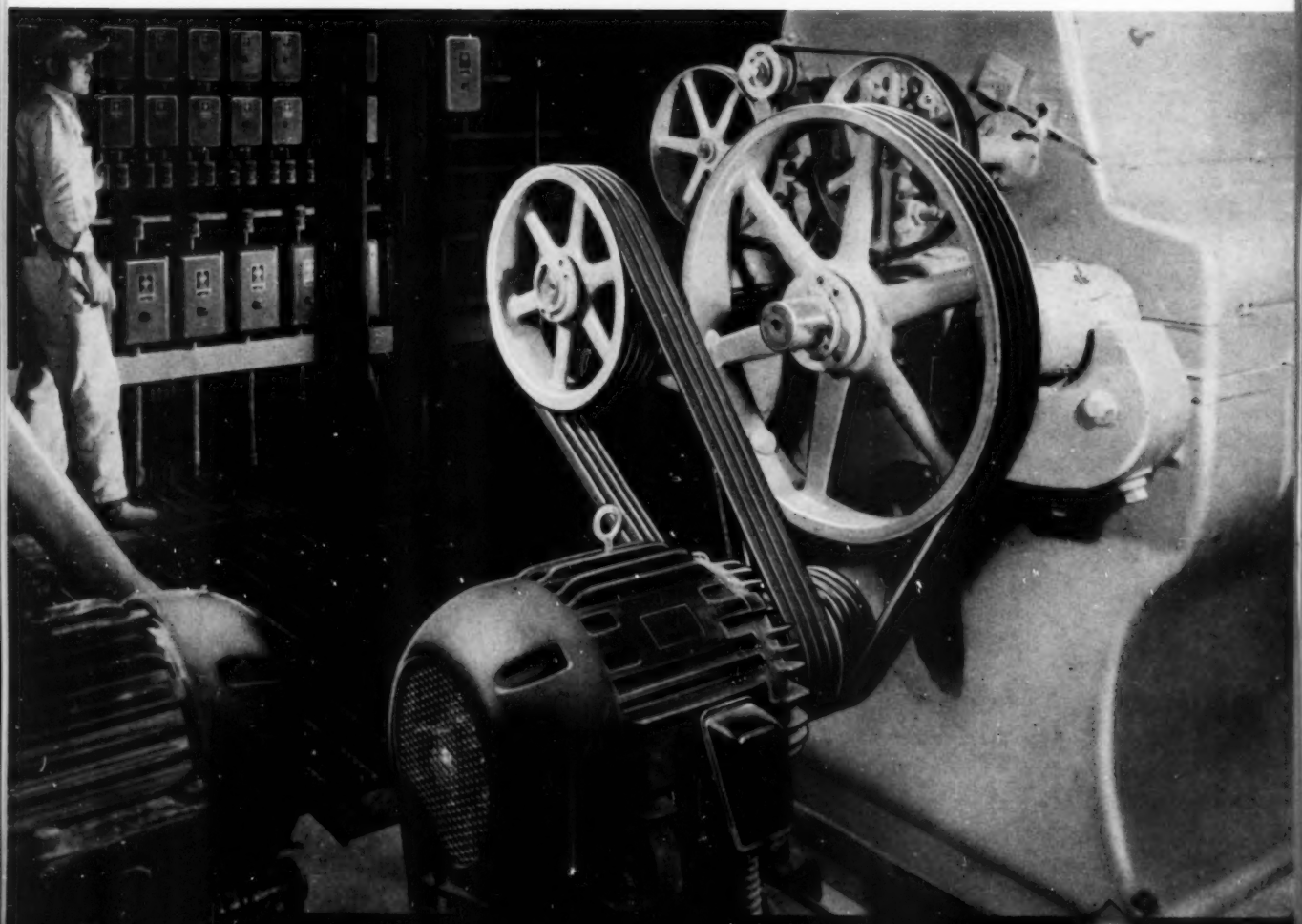
You will save time and engineering costs and reduce assembly problems when you use an Allis-Chalmers complete machine drive. Components are of coordinated design and manufacture. Ratings coincide and parts fit and work together properly when assembled. One requisition, one order, one invoice saves on paperwork. And you can obtain engineering assistance from qualified field application engineers who thoroughly understand the complete drive problem.

NATION-WIDE CERTIFIED SERVICE

Almost a hundred Allis-Chalmers Certified Service Shops in industrial areas in all parts of the country provide factory-approved service and parts. If you use a special motor, Certified Service Shops have the full benefit of factory drawings and advice for service work.

Call the Allis-Chalmers District Office near you next time you have a drive problem. A competent application engineer will be glad to put the full facilities of Allis-Chalmers at your disposal.

Texrope is an Allis-Chalmers trademark



ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Milwaukee 1, Wisconsin

The Company faced with cold forming this thread rolled depressed head machine screw said, "We just wouldn't attempt to make it from any standard grade of 18-8!"
When this Company was asked to produce a second lot of these sheet metal screws from a regular 18-8, here was the reply: "Impossible —there's too much punch breakage!"

What would *you* do

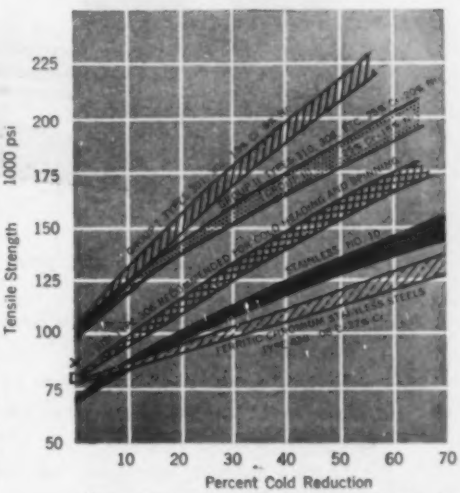
if you had to
mass produce
these fasteners
from 18-8 stainless
...without "losing your shirt"?

Both jobs were produced economically from a totally NEW chrome-nickel stainless!

Both companies successfully turned out these jobs with new Carpenter Stainless No. 10—the first chrome-nickel Stainless to permit economical, mass production of severely cold headed and upset fasteners and other parts. Carpenter No. 10 work-hardens far slower than any of the conventional 18-8 grades. That's the secret of its success. That is why it is ideal for cold headed bolts, screws, and upset nuts made on automatic machines. In fact, it is suited for any job involving heading, extrusion, severe coining and swaging. And the corrosion resistance of No. 10 is slightly better than Types 302, 304 and 305.

Of course, because of its high nickel content, Carpenter No. 10 is subject to present government regulations, and its supply is limited. Yet, we always like to keep you informed about the possibilities of a product like this. Upon request, we will be glad to give you more information about No. 10—its corrosion resistance, cold workability, machinability . . . as well as its usefulness for parts that must remain non-magnetic after severe cold working. So drop us a line on your Company letterhead, now . . . or any time. THE CARPENTER STEEL COMPANY, 117 W. BERN ST., READING, PA.

Export Department: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"



Comparison of various Stainless Steels showing increase of tensile strength with percentage of cold reduction.

Carpenter STEEL

Stainless No. 10

takes the problems out of production

Pioneering in Improved Tool, Alloy and Stainless Steels Through Continuing Research

for complete, unified tool-making service

. . . from rough sketch

. . . to finished stamping

Kirksite*

. . . proved-performance

tooling

Do you have to sweat out your own tooling problems?

Or, worse yet, do you have to farm out the work piece-meal?

Either way, it will pay you to investigate Kirksite Stamping Tool Service . . . a service *complete in every respect.*

In one unified operation, we can take your problem off your hands right from the idea, sketch, blueprint or model stage. We can make and finish patterns and dies. Then from these we can turn out try-out stampings or moderate production runs . . . *all in the same shop.*

You eliminate the need for "jack-of-all-trades" experience. You eliminate costly die-shop maintenance.

Better still, you by-pass the production difficulties of piece-meal operations and divided responsibilities.

All in all, the Kirksite "package" means fewer headaches . . . quicker production . . . lower costs!

If you make aircraft stampings, automotive vehicles, business machines; any die stamped parts, in fact, you ought to know more about this service. Write for "Kirksite," a free new booklet that gives you the up-to-the-minute facts on this complete service to cut tooling costs . . . tooling time. Address:

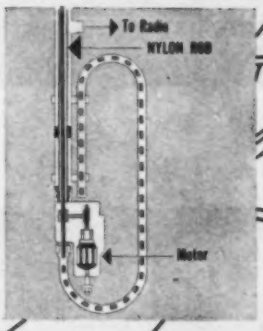
National Lead Company, Kirksite Division, 900 West 18th St., Chicago, Illinois.

Kirksite is a trade-mark registered in U. S. Pat. Off. by Morris P. Kirk & Son, Inc., a subsidiary of National Lead Co. *Reg. U. S. Pat. Off.

How mechanical parts of

DU PONT NYLON

give improved performance

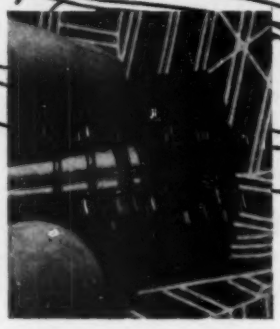


Automatic antenna has a flexible rod of Du Pont nylon that raises and lowers the "live" members. Nylon was the only material flexible enough to fold into the trombone-like position, yet rigid enough to force the antenna up and down.

Door-lock wedge of Du Pont nylon provides superior abrasion resistance, high resistance to repeated impact of door slamming. No maintenance required—needs no lubrication. Injection-molded production cuts costs.

Carburetor performance is improved with automatic spark-control unit that has ball check valve of Du Pont nylon. Lightweight nylon reacts instantly to pressure differentials . . . resists electrolytic and chemical corrosion.

Pedal-toeplate bumper seals with washers of nylon enabled engineers to cut in half the space required for floorboard clutch and brake seals. Du Pont nylon withstands abrasion . . . seals out noise, fumes, dirt and water.



Production operations were cut from five to one when this speedometer take-off drive gear was molded of Du Pont nylon to close tolerances. Long-wearing nylon resists abrasion . . . runs quietly . . . lasts life of the car.

Illustrated here are five examples of how Du Pont nylon plastic is improving performance and reducing costs of automotive parts. Forward-looking engineers are blueprinting many of their new ideas through Du Pont nylon's unique combination of mechanical and electrical properties.

Perhaps nylon's proven properties can help you engineer your present problem or future idea. For full information, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room 108 Du Pont Bldg., Wilmington 98, Del.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

GLOBE Seamless
GLOWELD Welded

- **Resistance to Corrosion**
- **Strength at High Temperatures**
- **Resistance to Oxidation at High Temperatures**
- **Ease of Fabrication**

TYPICAL ANALYSES AND TYPES:

302	309S	316Cb	330	410
302B	309Cb	317	347	430
304	310	321	403	443
308	314	329	405	446
309	316	INCONEL * — NICHROME **		

**Registered U.S. Trade-Mark* ***Trade-Mark Reg. U.S. Pat. Off. D-H Co.*

Globe produces more than 26 standard analyses of stainless steel tubes — also special analyses when required. Because varying analyses have widely varying service characteristics, Globe will make recommendations only after careful study of your particular problem.

GLOBE

specialization...

meets your exact requirements in

STAINLESS STEEL TUBES

Write for Bulletin 333 — Corrosion and Heat Resisting Steel Analyses Chart — a valuable reference tabulation of stainless steel analyses as produced by various manufacturers.

Piercing, rolling and reduction of seamless tubes is closely monitored from this control room — typical of the highly specialized equipment in the Globe mill.

SIZE RANGE:

Globe seamless stainless steel tubing may be had in sizes from ½ inch to 6 inches O.D., and in pipe sizes ⅛ inch to 6 inches, standard, extra strong and double extra strong weights.

Gloweld electric welded stainless steel tubing is available in sizes ranging from ¼ inch to 5 inches O.D. inclusive; in standard weight pipe (schedule 40) sizes ⅛ inch to 2 inches — lightweight pipe (schedule 5 and 10) ⅛ inch to 4½ inches inclusive.

TOLERANCE RANGE:

All stainless tubing furnished to standard A.S.T.M. specifications unless otherwise specified to suit your particular application requirements.

Globe specialization gives you uniform high quality...

Precision checks — and re-checks — at every stage of production insure Globe stainless steel tubes that meet *your* exacting specifications. For more than thirty years, specialization in production of steel tubes has key-noted all Globe research, engineering and mill operations. Write for the Globe Stainless Steel Tubes catalog.

GLOBE STEEL TUBES CO., Milwaukee 46, Wis.

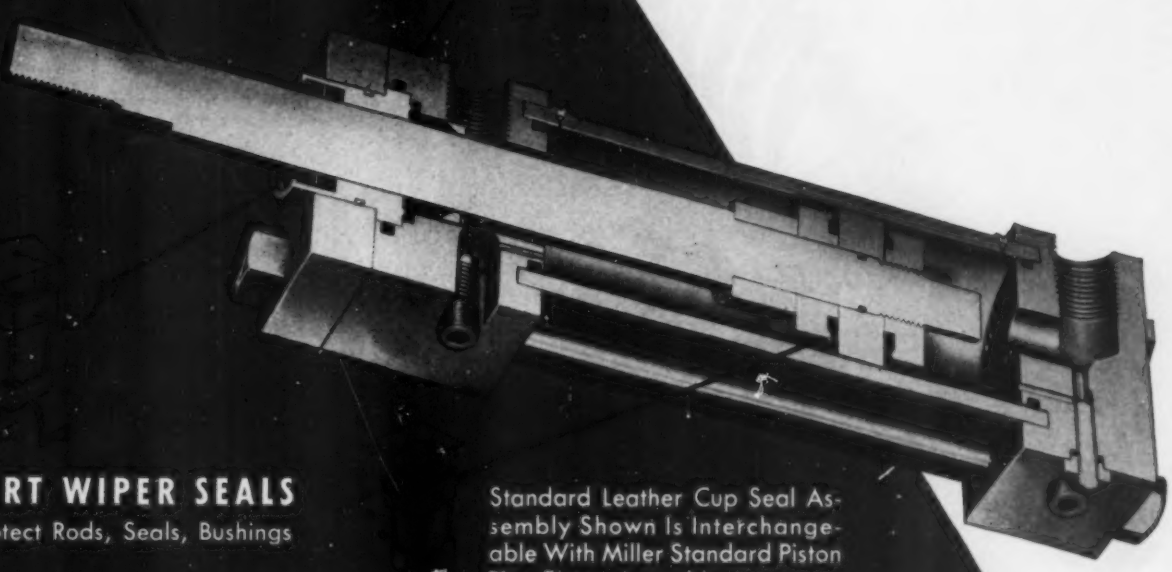
Chicago — Cleveland — Detroit — New York — Philadelphia — St. Louis — Denver — Houston — San Francisco — Glendale, Cal.

Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — alloy — carbon seamless steel tubes — Globeiron (high purity ingot-iron) seamless tubes — Globe welding fittings.

Miller HIGH PRESSURE HYDRAULIC CYLINDERS

HARD CHROME PLATED PISTON RODS
Prevent Scratch-Damage, Nicks and Rust

SOLID STEEL HEADS, CAPS and MOUNTINGS
Eliminate Breakage



DIRT WIPER SEALS
Protect Rods, Seals, Bushings

Standard Leather Cup Seal Assembly Shown Is Interchangeable With Miller Standard Piston Ring Piston Assembly

WRITE FOR CYLINDER BULLETINS H-104 and A-105

Complete Miller cylinder line includes: air cylinders, 1½" to 20" bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

MET J. I. C. HYDRAULIC STANDARDS years before their adoption in 1949.

SPACE-SAVING SQUARE DESIGN originated by Miller in 1945.

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Miller

MILLER MOTOR COMPANY

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AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

DE LAVAL WORM GEAR SETS *can take "hard knocks"*

1 Bronze gear teeth retain true form over long periods of service due to the regenerating action of the hardened steel worm. In fact, the efficiency actually improves as the gear "wears in".
2 Three or more teeth are in contact with the worm at all times. The flow of power is smooth, continuous and vibration free.
1
2
High Shock Load Capacity
Standard 14½° involute spur gear tooth and old time worm tooth.
20° stub spur gear tooth.
Line of Pressure
De Laval Worm Gear tooth. Note line of pressure falls inside base of tooth.
Write on your business letterhead for Catalog 5000

De Laval worm gear sets are designed to take punishment year-in, year-out. Gear teeth are under a crushing, instead of a bending load. Thus they withstand extremely high momentary and shock loads damaging to other forms of gearing. They need little attention even under the most rugged operating conditions.

De Laval manufactures these heavy-duty sets in a wide range of ratios from 3:1 to 100:1, with ratings of .1 hp to 550 hp and center distances from 3″ to 36″. It pays to design around these De Laval stock sizes. Special sets, however, can be furnished to any detailed specifications.

Proven applications of De Laval worm gear sets include the machine tool industry, rolling mills, process machinery, cranes and hoisting equipment and many similar uses.

DE LAVAL *Worm Gear Sets*

DE LAVAL STEAM TURBINE COMPANY
801 Nottingham Way, Trenton 2, New Jersey

put 43 years of experience to work for you...

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. . . produced under controlled process technique that insures quality.

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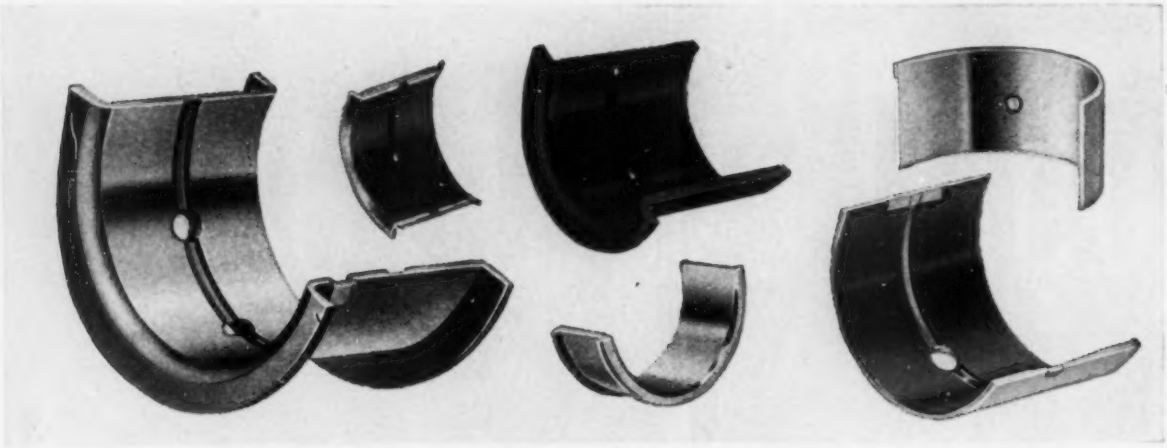
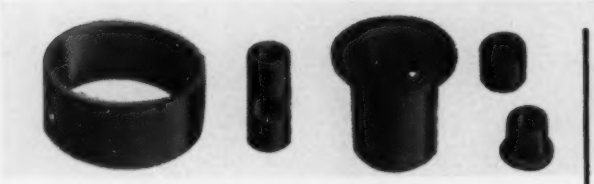
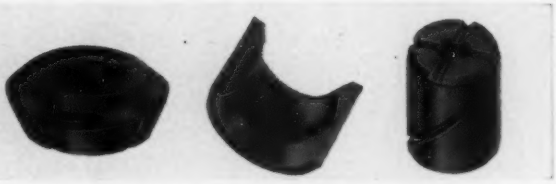


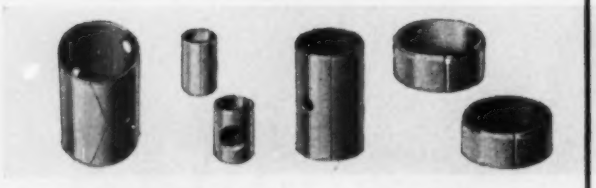
Sleeve bearings in a wide variety of designs and sizes



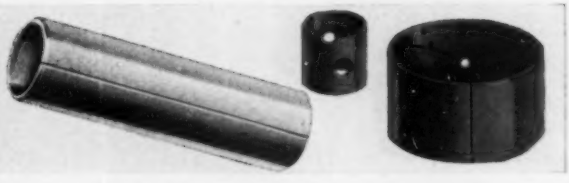
Cast bronze bushings



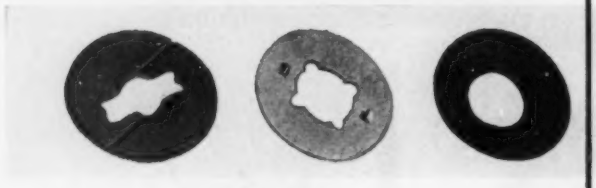
Precision bronze parts



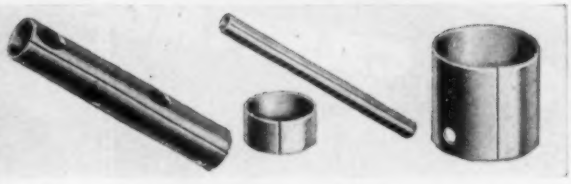
Bi-metal split bushings



Rolled split bushings



Washers



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FEDERAL Mogul

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To clock-radio designers
who fall back to sleep

don't forget the Signal Alarm
...available only on Telechron Timers

Model C-78

Sleep through the soft morning music of your clock-radio *just once*, and you'll see an important reason to specify Telechron Timers with signal alarm for your new models. And you'll see, too, how this exclusive feature can help your clock-radio become a sales success.

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For any clock-radio price class, there's a Telechron Timer that will meet your needs. We custom style to meet your design requirements. Write for details. Telechron Department, General Electric Company, 18 Homer Ave., Ashland, Mass.

Telechron SEAL OF ACCURACY

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Telechron Seal of Accuracy on the clock crystal or our trademark on the dial gives the buyer confidence in the accuracy of your clock-radio.

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GENERAL PLATE

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(COPPER-CLAD ALUMINUM)

Reduces Costs

OVER SOLID COPPER OR BRASS

ALCUPLATE Provides High Electrical Conductivity, Soft-Soldering Surfaces, Good Heat Dissipation, Light Weight

Now, you can reduce your cost 15-30% or more over an equal area of solid copper or brass by using General Plate ALCUPLATE.

Made by *permanently bonding* a thin layer of copper to one or both sides of thicker aluminum, ALCUPLATE has practically the same physical and electrical properties as copper, plus the light weight of aluminum. The copper provides an ideal surface for soft-soldering operations, electroplating and other finishes.

ALCUPLATE is widely used in the electrical and electronic fields for terminals, clips, shims, small motor housings, electronic component cases, chassis, and brackets. It is also used for heat transfer assemblies, fin and tube type radiators, printed circuits, costume jewelry and similar applications.

ALCUPLATE can be fabricated by stamping, drawing or forming. Its malleability permits its use in the manufacture of many parts from work-hardened rather than annealed or dead soft materials.

ALCUPLATE is available in coils and flat cut lengths, copper clad on one or both sides of aluminum, 1/16" thick x 13" wide and under.

Technical Data Bulletin No. 702C gives full details. Write for a copy, today.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
18 FOREST STREET, ATTLEBORO, MASS.

A Few of the Many Products Made from General Plate ALCUPLATE

HEAT TRANSFER UNITS — ALCUPLATE provides ideal fin sections at reduced cost over solid copper fins. The copper surface permits the soft soldering of the fins to the tubes.

ELECTRONIC CHASSIS — Minimum weight combined with copper surface required for soft-soldering operations, electroplating, and low-resistance shield connections are advantages obtained by using ALCUPLATE.

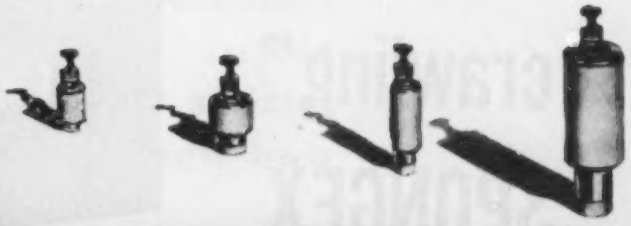
COMPONENT CASES — ALCUPLATE is successfully drawn and formed into lightweight cases or cans and intricate parts.

BUS BARS — ALCUPLATE provides high conductivity, light weight, solderability . . . and is lower in cost than solid copper bus bars.

ELECTRICAL TERMINALS — Small terminals and large pressure-type connectors use single-clad ALCUPLATE . . . alleviates galvanic corrosion which otherwise results from aluminum and copper junctions.

for hermetically sealed electrical components

ALSIMAG® *standard* METALLIZED HERMETIC TERMINALS



VITRIFIED ALUMINA MATERIAL . . . SUPERIOR METAL-CERAMIC BONDING

Reasonable quantities of all Standard Designs in stock for immediate shipment. Special Designs made to your specifications.

COMPLIES WITH LSA REQUIREMENTS OF JAN-I-10 SPECIFICATIONS

Bulletin No. 524 Sent on Request

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Ends "vibration crawling" SPONGEX Cellular Rubber

Courtesy of Cincinnati Time Recorder Company.

Vibrations caused this time recorder to crawl on smooth surfaces. To end this annoyance, The Cincinnati Time Recorder Company uses an inexpensive base pad cut from a sheet of Spongex cellular rubber. This pad firmly holds the recorder and avoids the inconvenience of permanent installation of the machine.

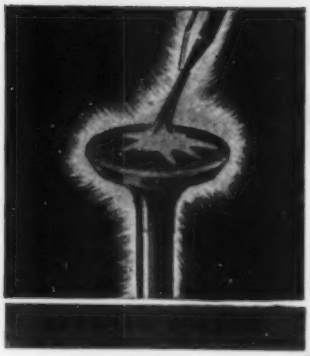
Similar Spongex pads are equally effective in eliminating "vibration crawling" on other types of portable machines, such as electric fans, paint sprayers and movie projectors. In each case, this inexpensive extra increases efficiency and ends annoyances for customers.

Perhaps *your* customers would appreciate the "hold-ability" of Spongex pads. Write today for further information on the applications of Spongex cellular rubber sheet stock to portable machines.

SPONGEX® Cellular Rubber

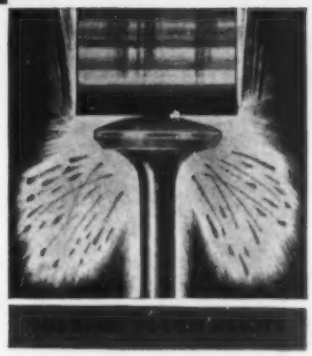
for cushioning, insulating, shock absorption, sound and vibration damping, gasketing, sealing, weatherstripping and dust proofing.

THE SPONGE RUBBER PRODUCTS COMPANY 602 Derby Place, Shelton, Conn.



These facilities ...this special know-how

...may hold ideas YOU can use NOW



Every day the Valve Division is welding thousands of pounds of high-alloy coatings to unusual Thompson-developed alloys to give internal-combustion engine valves added life under super-severe service.

We also insert highly-combustible metallic sodium into hollow valve stems to make engine valves run cooler and last longer.

The Valve Division also knows plenty about forging and finishing extra-tough alloys to precision limits.

If you have out-of-the-ordinary production problems, you'll want to know more about Thompson know-how and facilities. And, if you have ideas about how we can help on new projects, we'd like to talk them over with you.

VALVE DIVISION

Thompson Products, Inc.

DEPARTMENT VE-8 • CLEVELAND 17, OHIO

20 big-name Refrigerator Makers save with Spring-Lock Shelf Supports

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Seeger Refrigerator Co.
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Acme National Refrigeration Company
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Liquid Carbonic Canadian Corporation, Ltd.
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Fleet Mfg. Co., Ltd.
Racine Manufacturing Co., Ltd.
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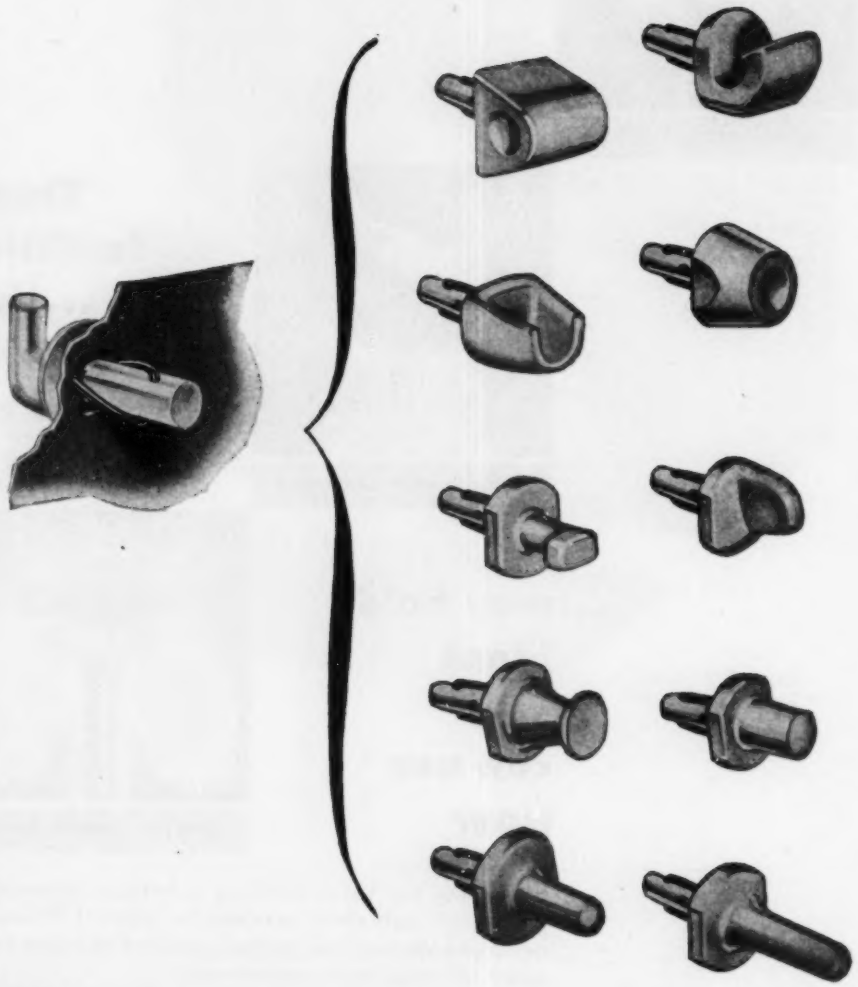
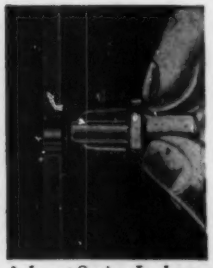
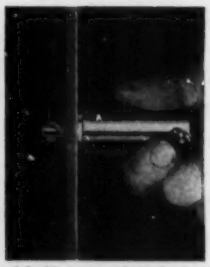


HERE'S HOW SIMPLE IT IS TO INSTALL SPRING-LOCK



1. Insert Spring-Lock



2. A half turn and it's locked

The steel insert carries the load.

Twenty leading refrigerator makers in the United States and Canada find Simmons plastic SPRING-LOCK the ideal shelf support. It is strong, attractive and low in cost. Installation is blind, easy, quick, secure. Insert the fastener, then a half-turn causes the spring-steel legs to grip panels securely.

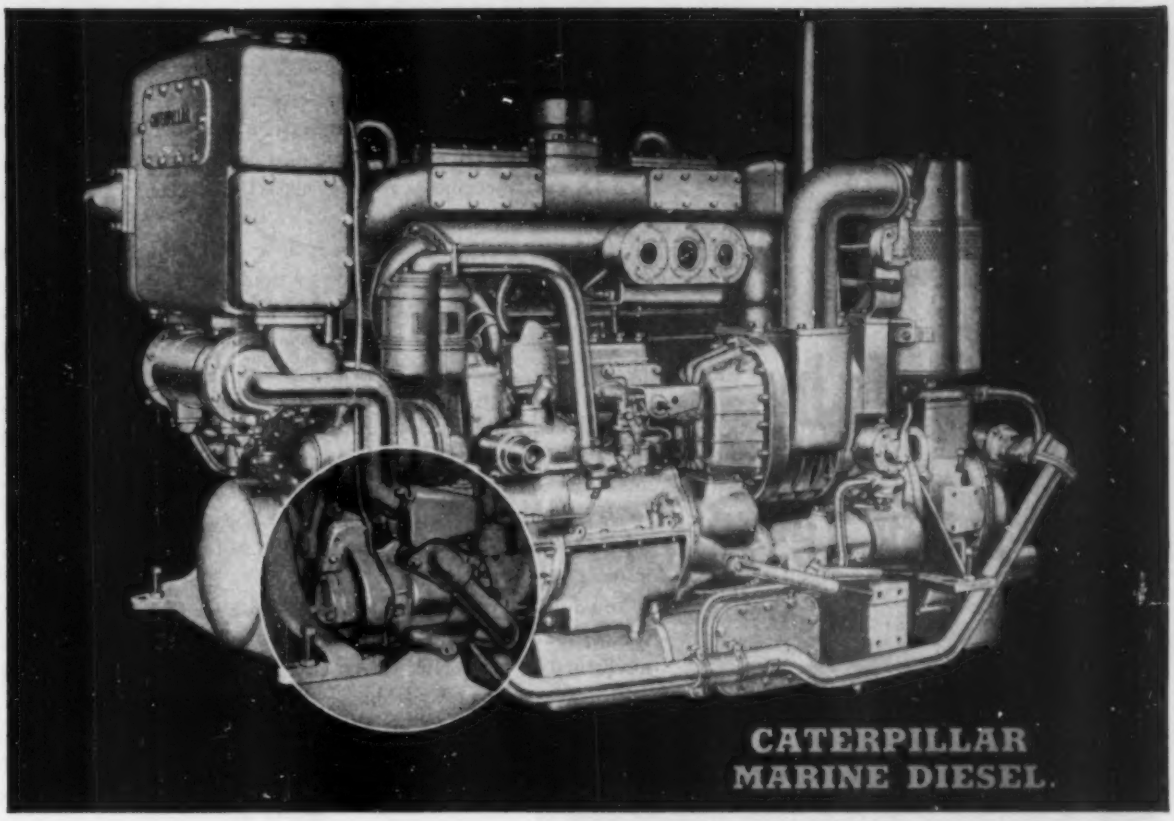
Design flexibility of SPRING-LOCK makes it suitable for a variety of applications: shelf supports, cover knobs, drawer pulls and many other uses. Any shape head can be molded in any color; the heart of steel, around which the plastic is molded, provides strength-plus.

If you have a fastening problem, Simmons engineers will be glad to help you solve it. Send us the details today.

Simmons Fastener Corporation, 1751 North Broadway, Albany 1, N.Y.

Simmons QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

JUST OUT! NEW 36-PAGE CATALOG WITH APPLICATIONS SEND FOR IT!



National Bearing Castings Help Cool "Cat" Engines

National Bearing Division's foundry skill permitted a new design in pump efficiency and compactness.

This extremely compact 170 horsepower Marine Diesel Engine, with special coolant pump, is a new design in efficiency by Caterpillar Tractor Co., Peoria, Illinois, makers of famous "Caterpillar" Diesel Engines, Tractors, Motor Graders, and Earthmoving Equipment.

Unusual size restrictions were specified in the coolant pump housing. It had to be of tough, durable bronze, highly resistant to corrosion by raw sea water, and painstakingly cast as the housing component for a very compact coolant pump, capable of delivering 100 gallons per minute. The housing casting design was unusually intricate, with wall thicknesses exactly ¼" in some areas, 7/32" in others. The mold for each casting required *14 cores*—all perfectly positioned, as the slightest misalignment would be ruinous. And, housings had to be cast to minimize machining.

"Caterpillar" selected National Bearing Division to provide these special bronze pump housings. We were chosen for proven ability to produce top quality castings, our unique core facilities, and our experience in applying over 50 years of specialization to customers' problems.

Our bronze pump housing castings met—and continue to meet — "Caterpillar's" specifications for quality, tolerance, and minimum machining in every respect.

If your product includes copper, bronze, or other copper-base castings, it will be worth your while to investigate National Bearing Division. We produce copper-base castings, large or small, with any degree of finish, to precision specifications. And, because we are set up for production runs, we can probably save you dollars.

Write to National Bearing Division for complete information and your copy of our catalog.

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

4932 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

Half mile of HELIARC TRADE MARK welds OK'D by rigid X-ray tests

A midwest manufacturer was faced with the problem of getting X-ray quality welds in aluminum vessels. These welds were subject to pressure and had to be entirely free from porosity and oxide inclusions. After thoroughly investigating customer specifications, LINDE's service engineers recommended HELIARC inert gas shielded welding for the job.

Since then, about a half mile of these HELIARC welds have been OK'd by 100% X-ray inspections. According to company officials, HELIARC welding was "perfect for the job" and meant real savings by getting X-ray quality welds the first time without expensive rejections or repairs.

Whether you weld aluminum or other hard-to-weld metals, you, too, will find that fast, clean, HELIARC welding will save you time and production costs. HELIARC welding takes place under a shield of inert argon gas which eliminates the need for flux. As a result, HELIARC welds are free from porosity and oxide inclusions. This means fewer rejects and lower finishing costs. In fact, spatter-free HELIARC welds in many cases can be left "as welded."

You owe it to yourself and to your Company to find out more about the cost saving benefits of HELIARC welding. Call your local LINDE representative today. He will be glad to furnish you with detailed information on HELIARC welding.

LEFT Welding heavy aluminum sections with HELIARC *HW-10 torch. These welds were strong, dense, and required little finishing. BELOW The 300 amp.* HELIARC *torch has all-internal water-cooling of both torch head and power cable for cool, long-lasting operation. The HW-10 also features quick electrode adjustment.*

Linde TRADE-MARK

LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation

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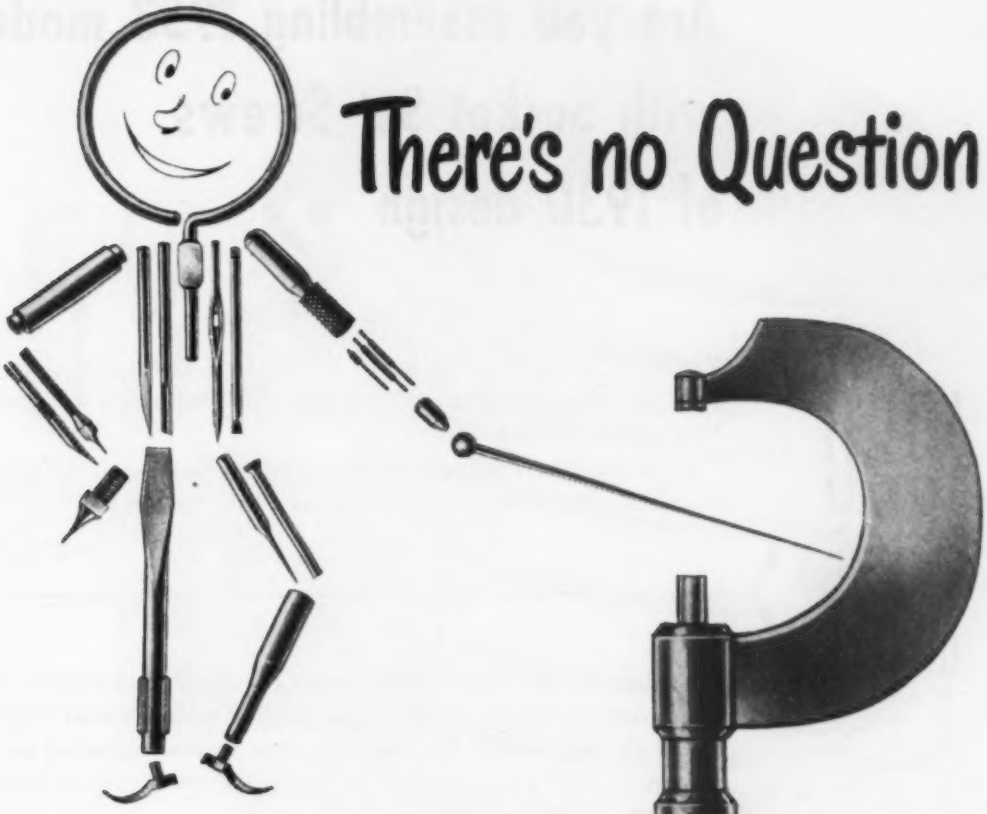
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

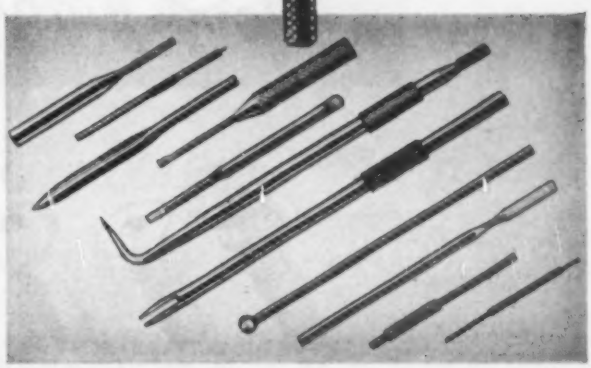
"Heliarc" and "Linde" are registered trade-marks of Union Carbide and Carbon Corporation.

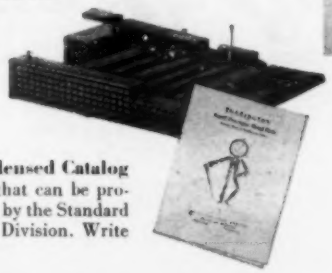
There's no Question



...about the quality of
Torrington Small Precision Metal Parts

If you need pins, pivots, punches, mandrels, shafts, needles or other small metal parts made to fine tolerances, let Torrington make them for you... faster, better, and *for less* than you can. Special automatic machinery gives you custom-quality drawing, grinding, swaging, knurling, slotting, thread rolling, etc., on production runs of a thousand or a million pieces. Send your blueprints or a sample part for a prompt quotation.





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THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.
Makers of
TORRINGTON NEEDLE BEARINGS

Are you assembling 1953 models with Socket Set Screws of 1930 design ?

Take a look at the Socket Set Screws in many 1953 models of machine tools, plant apparatus, appliances, etc., and you'll find they are no different from those used in 1930 or before.

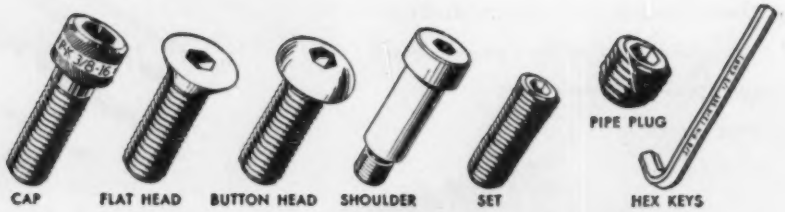
If you think there has been no change in such fasteners since 1930, you haven't seen Parker-Kalon *Ground Thread* Socket Set Screws.

Their clean, smooth, shining threads assure easy keying, and faster assembly. But equally important is the design prestige P-K Ground Thread Socket Set Screws give any product. Any buyer associates modern engineering and top-most quality with a gleaming thread finish he has seen before only on costly set screws of instrument precision.

Compare them with any cut-thread socket set screws and you'll see the day-and-night difference. Then specify "P-K *Ground Thread*" on your next order. Put your product out in front, assembly-wise and sales-wise.

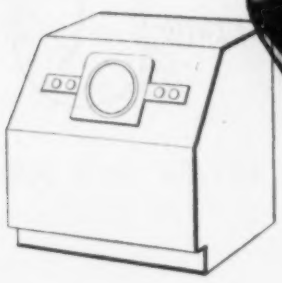
For SAMPLES, ask your P-K Distributor, or write: Parker-Kalon Corporation, 200 Varick St., New York 14.

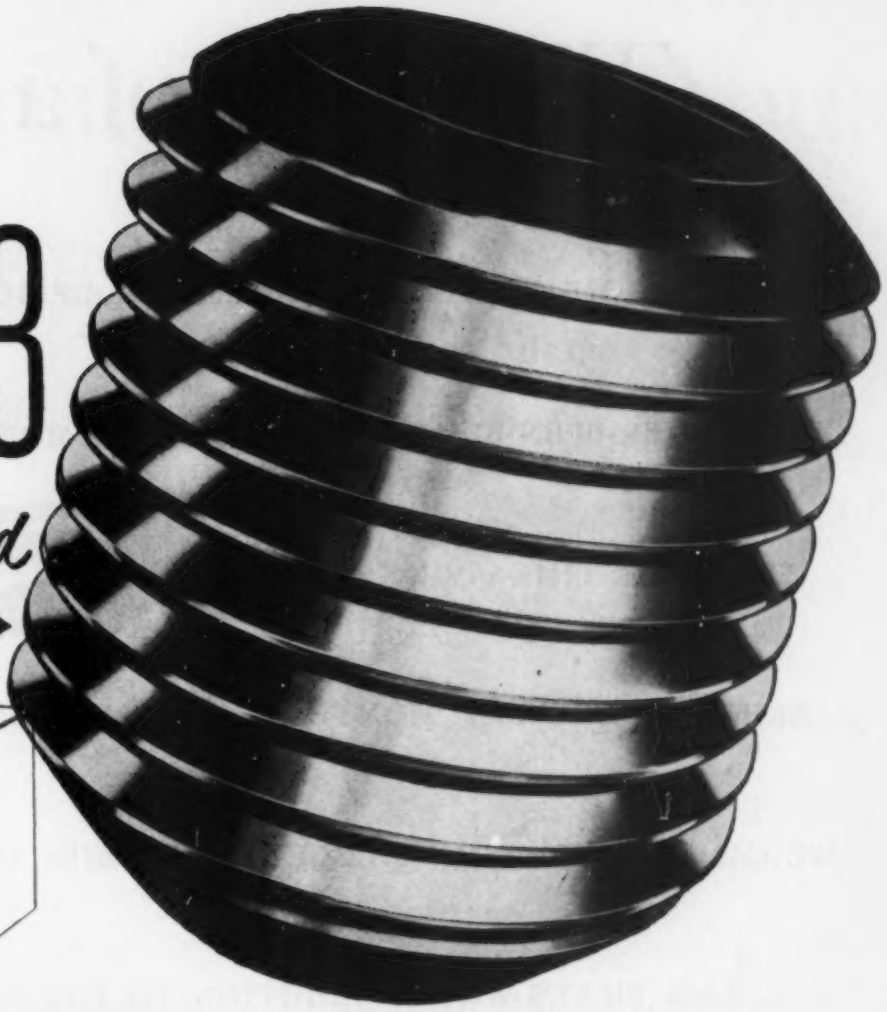
Good judgment calls for [redacted]



1953

Ground Thread

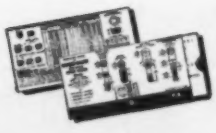




PARKER-KALON®

when good design calls for

SOCKET SCREWS



SOCKET SCREW DIMENSION FINDER

Helps you plan assemblies. Pocket-size plastic chart gives essential dimensions of all types of P-K Socket Screws. Includes Set Screw Point Dimensions, and Thread Length Formula. Available FREE from your P-K Distributor.

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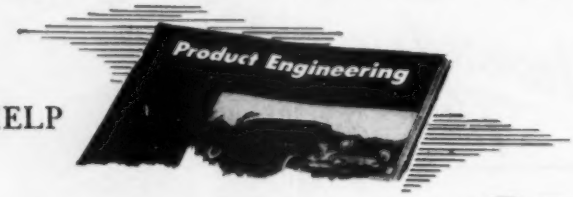

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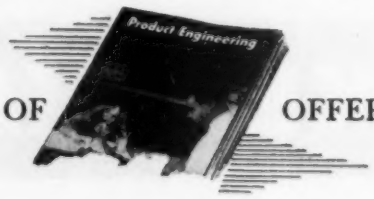

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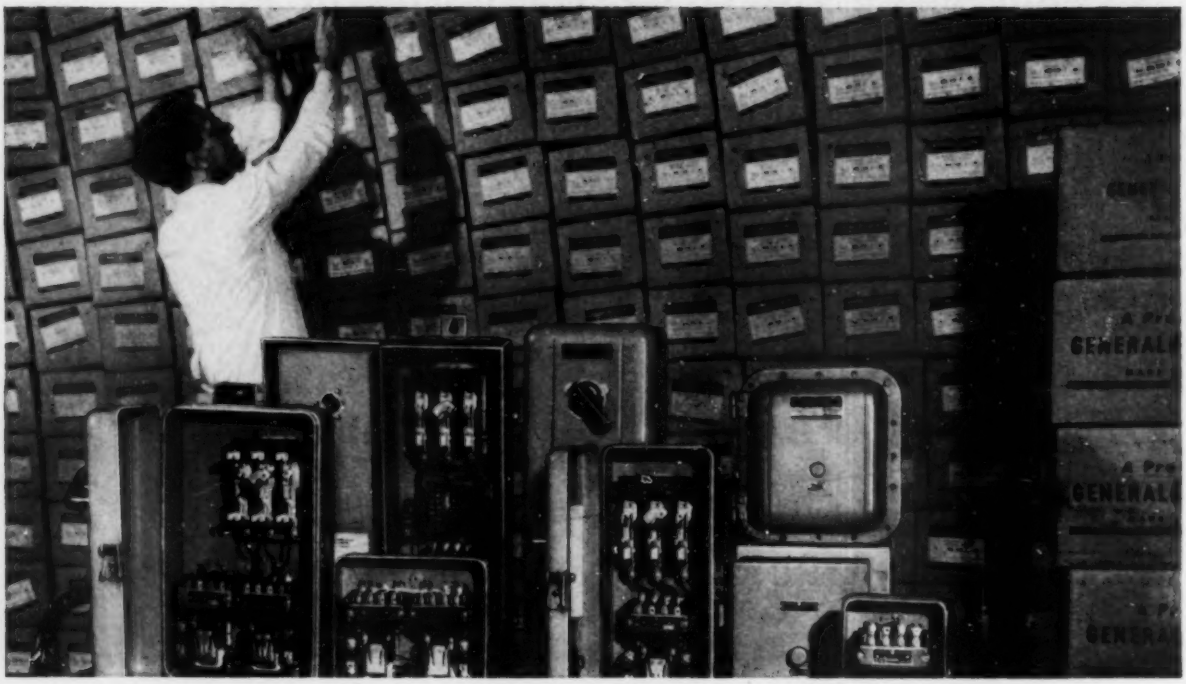
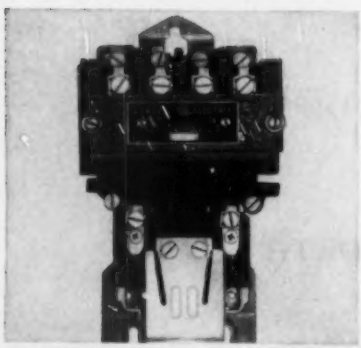
Designer's



Dependable G-E magnetic starters meet any motor-starting application



CONTROL SUPERIORITY from this basic contactor and its many combinations of accessory components enables you to handle the most severe industrial applications.

Available in designs to fit every need

No matter what your design requirements, you can get a General Electric starter to fit your particular motor application. Hundreds of variations of across-the-line, combination, reversing, and multi-speed starters are available for a-c motors.

EXTRA INTERLOCK CONTACTS—as many as four on sizes 0 to 1, three on sizes 2 and 3—can be added to the standard starter.

CONTROL TRANSFORMERS for operator protection, and control relays are standard components.

START-STOP push buttons or Hand-Off-Auto selector switches can be mounted in the cover.

ENCLOSURES include general-purpose, watertight, dust-tight, semi-dust-tight, explosion-proof and types that meet JIC specifications.

PLENTY OF WIRING SPACE so contacts, coils and overload relays can be removed quickly, conveniently.

PROMPT DELIVERY is assured—just contact your nearest G-E Apparatus Sales Office. For more details write for Bulletin GEC-880.

GENERAL ELECTRIC

Digest

MOTOR & CONTROL HIGHLIGHTS

G.E. to follow new NEMA motor standards: To offer more horsepower in smaller frame

Samples of first two frame sizes available in late fall, 1953

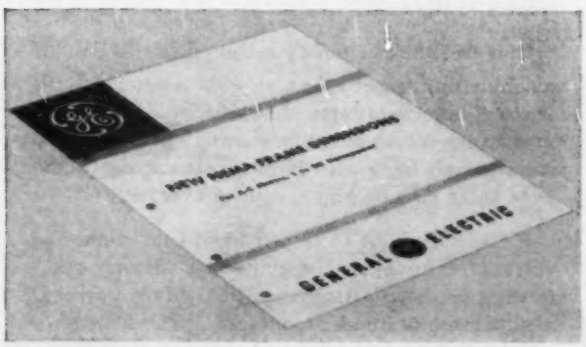
The new NEMA motor frame dimensions for a-c motors, 1 to 30 horsepower, take advantage of better materials and advances in the art of motor design to give you better utilization of space within frames and greater horsepower per frame size. This is the first major re-rating program for these sizes in the motor industry in 24 years.

General Electric will have the new 182 and 184 frame polyphase motor designs completed and samples available by late fall, 1953. Quantity production sufficient to adequately serve customers will follow shortly thereafter. Larger frames will be available at later dates.

While this program introduces some new frames, the total number of frame diameters for this range of ratings is reduced and the performance characteristics remain unchanged. You will welcome these new motors, because they offer savings in weight and space, without any sacrifice in performance. So that you may lay plans now to realize the benefits of these new motors as they become available, the bulletin below has been prepared.

HP	3600 RPM		1800 RPM		1200 RPM		900 RPM		720 RPM		600 RPM	
	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW
½	—	—	—	—	—	—	204	182	—	—	—	—
¾	—	—	—	—	203	182	224	184	—	—	—	—
1	—	—	203	182	204	184	225	213	254	213	254	215
1½	203	182	204	184	224	184	254	213	254	215	284	254U
2	204	184	224	184	225	213	254	215	284	254U	324	256U
3	224	184	225	213	254	215	284	254U	324	256U	326	286U
5	225	213	254	215	284	254U	324	256U	326	286U	364	324U
7½	254	215	284	254	324	256U	326	284U	364	324U	365	326U
10	284	254U	324	256	326	284U	264	286U	365	326U	—	—
15	324	256U	326	284	364	324U	265	326U	—	—	—	—
20	326	284U	364	286	365	326U	—	—	—	—	—	—
25	364S	286U	364	324	—	—	—	—	—	—	—	—
30	364S	324S	365	326	—	—	—	—	—	—	—	—
40	365S	326S	—	—	—	—	—	—	—	—	—	—

Ratings for new open-type polyphase motors, designs A and B



Bulletin GEA-5995 shown above is available to give you the new NEMA standards (the chart above is a sample), including dimension information. As a service to our customers, we will release more details about G-E motors in the new NEMA frames, as such information becomes available.

General Electric Company
Apparatus Sales Div., Sect. C668-104
Schenectady 5, New York.

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☐ GEA-5995 New NEMA Frame Dimensions

☐ GEC-880 Magnetic Motor Starters

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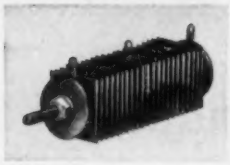
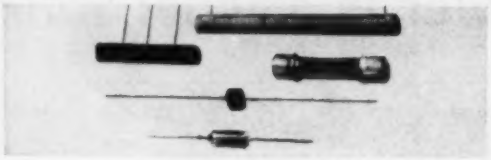
TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS

VERSATILE G-E SELENIUM RECTIFIERS SOLVE YOUR D-C POWER PROBLEMS



Standard stack construction

Tube-mounted construction

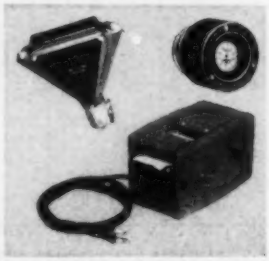


Miniature cell assemblies

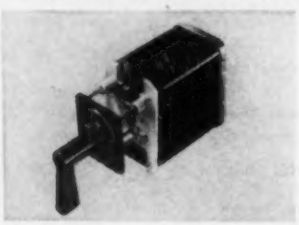
For a dependable, economical, and practical way of converting a-c to d-c for control or power uses, check General Electric selenium rectifiers. These long-life, stable selenium-cell assemblies have high reverse and low forward resistance. They meet machine designer's exacting and varied demands—conform to government specifications. For aid in your design work, send for Bulletin GET-2350, covering rectifier fundamentals, circuits, and applications.

VIBRATION-MEASURING EQUIPMENT GIVES YOU QUALITY-CONTROL AID

To check excessive vibrations that cause damage to machinery and buildings, use these G-E vibration-measuring instruments. Shown are (top, right) general-use dial-type indicator, (left) light-beam type unit, and (bottom), recording vibrometer. For full data on these quality-control aids, see Bulletin GEC-853.



ALL-PURPOSE G-E SWITCH CAN HANDLE 10,000 CONTROL AND TRANSFER JOBS



For practically any control job on low-capacity circuits you can use the versatile General Electric Type SB-1 switch. By varying its many standardized, interchangeable parts this versatile switch makes over 10,000 control and transfer combinations. The same simplified construction applies to the Type SB-9 for extra heavy duty. For complete information on SB-1 types, write for Bulletin GEA-4746.

COMPACTNESS AND SIMPLIFIED WIRING of G-E general-purpose transformers saves valuable installation time on this multi-slide machine made by U. S. Tool Company of Ampere, N. J.

G-E dry-type transformers go in fast, save space

The U. S. Tool Company, manufacturers of special production machines and tools, find that General Electric's dry-type transformers handle a variety of voltages, go in fast, save space, and reduce inventory and storage costs. Says Mr. Kay Krausse, assistant purchasing agent, "In the ten years I've been buying G-E transformers we have never had a failure or any complaints from our customers in the field."

This transformer family includes a standard line of machine-tool transformers as well as general purpose units. They have been designed by G.E. to cover practically all in-put conditions. The machine-tool transformers have built-in protection against damage from short circuits and sustained overload.

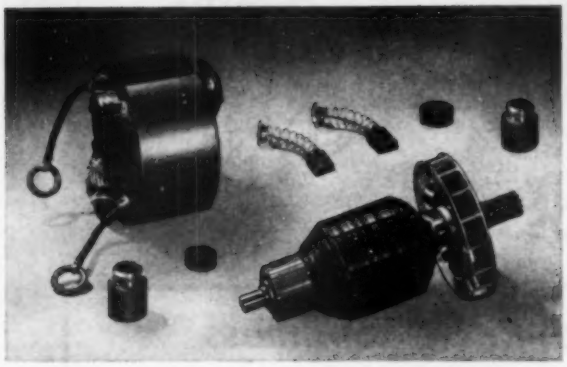
For the machine-tools *you* build—no matter what voltage requirements—specify G-E dry-type transformers for long-lasting operation. Many ratings are available for all standard voltages and frequencies. Ask your G-E Apparatus Sales engineer for full data.

GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS

COMPLETE LINE OF SERIES MOTOR PARTS BUILDS QUALITY INTO HAND-TOOLS

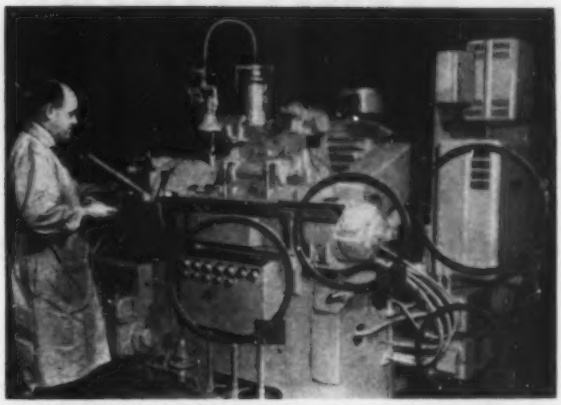


Whatever your hand-tool drive problem may be—whether you build the smallest of intermittently rated devices, or the most rugged machines for heavy duty service—you'll find a General Electric series motor that fills your needs. The parts which you build into your machine tool must have accurate dimensions. All G-E series motor parts dimensions are checked to drawing tolerances by sensitive indicators, minutely inspected for imperfections. The flexibility of its dependable operating components can be keyed to your design requirements by G-E engineering help. For descriptive information on G-E series motor parts see Bulletin GEA-5665; for selection and application data check Bulletin GET-2297.

PROMOTES LONG-RANGE MACHINE SALES: PROGRESSIVE MECHANIZATION PROGRAM

"Progressive Mechanization," General Electric's new More Power to America Program, offers industry a planned, step-by-step approach to greater mechanization.

Addressed to *your* customers, it can promote new long-range sales for your machines as a means to increased productivity, lower costs. Program includes sound-color movie, "how-to" manual, and survey form, described in Bulletin GEA-5789.



THY-MO-TROL® DRIVE for work heads and traverse on this automatic cylindrical grinder consists of (1) motor, (2) control panel, (3) anode transformer, and (4) operator's control station.

G-E adjustable-speed drive diversifies machine output

With G-E's new, standardized ¾ to 10 hp Thy-mo-trol drive, you get smooth, stepless, pre-set speed control, precise speed regulation, and dynamic braking. Speed ranges are 5:1, 20:1, and 50:1.

Whatever your need, there is a G-E Adjustable-speed drive for you. Fundamental speed adjustment is available from the ACA motor; precise speed control with Speed Variator. G-E packaged drives are available from 1/40 to 200 hp. For full line of Adjustable Speed Drives, check Bulletin GEA-5334.

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- ☐ GEA-4746 SB-1 Control Switch
- ☐ GEA-3827 Thy-mo-trol Drive, ¾ to 10 hp
- ☐ GEA-5334 Adjustable Speed Drives
- ☐ GEC-853 Vibration-Measuring Equipment
- ☐ GEA-5665 Series Motor Parts
- ☐ GEA-5789 Progressive Mechanization Program
- ☐ GET-2297 Selecting Series Motor Parts
- ☐ GET-2350 Selenium Rectifiers

Consult Your McGraw-Hill Electrical Catalog For Product Engineers! You'll find "everything electric" for machinery manufacturers in the General Electric section.

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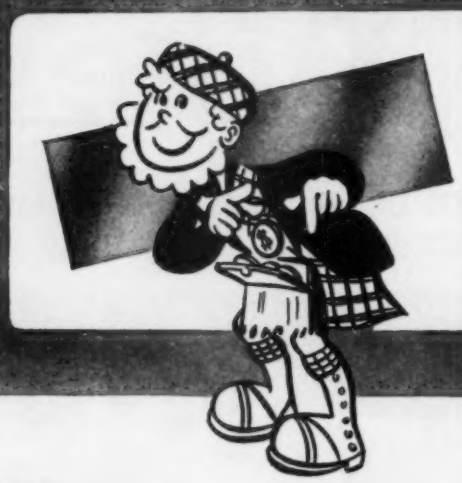
the 3rd. DIMENSION



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Here's how *MicroRold*® Stainless Steel *Saves You Money*

The third dimension, or gauge thickness, is extremely important in the purchase and use of stainless steel. Job costs are figured on a square foot of stainless area basis while stainless sheets are purchased on a weight basis. Each one-thousandth inch saved in thickness saves 1.26 pounds per sheet.*

When sheets are ordered by gauge number, the permissible A.I.S.I. variation in thickness is plus or minus 10%. Thus, if you order 18 gauge you may receive sheets .052″ thick, when a thickness of .0475″ would suit your purpose. Using a standard 18 gauge 36″ x 120″ sheet as an example, the theoretical weight is 63.00 pounds, but this weight could permissibly vary between 59.22 pounds and 65.52 pounds.

MicroRold sheets may be ordered by gauge number and you may specify they be rolled on the light side of the gauge range. This is true because the company's equipment is such that more accurate control of thickness is possible.

If you are not a user of MicroRold sheet it will pay you to get the full details. Your steel warehouse distributor will gladly tell you the MicroRold story.

*36″ x 120″ standard size sheet.

WASHINGTON STEEL CORPORATION

Washington, Pennsylvania

Perspectives ~ DESIGN AND DEVELOPMENT

BASIC RESEARCH

At a recent congressional hearing, Defense Secretary Charles E. Wilson stirred up a hornet's nest of scientific criticism when he told the lawmakers that the Pentagon would no longer finance basic research. His action slashed the largest government support of fundamental studies. Actually the attacks were unwarranted. Wilson had put his finger on one of the stickiest problems in scientific administration, one that is far more complicated than the question of armed forces support.

Prior to World War II, the United States usually left "delving into the purest realms of science" to Europeans. American forte was to import theoretical discoveries and convert them into highly practical devices.

THE BIG PROBLEMS

After the war when American authorities decided the U.S. should do its own basic research they ran into three tough problems: 1) How much should be done? 2) Who should do it? and 3) Who should pay for it?

Scientists hoped to build a structure similar to the one that made Germany a first class technological nation (see page 207). The foundation: government subsidy and recognition for researchers. Washington responded by setting up 1) the National Science Foundation to finance theoretical studies in all fields, 2) the National Research Council, and 3) the National Academy of Sciences. In addition, the Defense Department's Research and Development Board started alloting funds for fundamental studies, up to six percent of its entire budget (over $30,000,000 last year).

In practice, the technical groups never attained important status. Congress failed to supply the money to make them effective.

That's why some scientists attacked Wilson's plan to stop Pentagon support of fundamental research. They figure that a "bird in the hand is better than the proverbial two in a bush".

Other scientists would like to see the problem solved properly. They agree that the Pentagon, with its emphasis on armament, is not the group to support basic science. Here's what they're saying:

HOW MUCH?

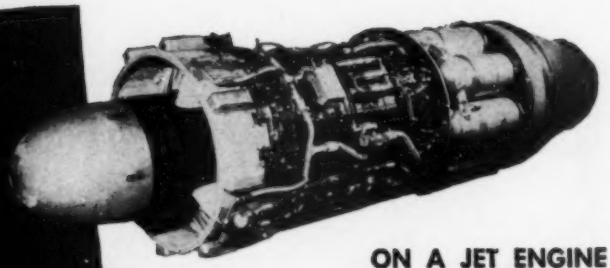
Technical men don't like the idea of setting a limit on research, particularly fundamental studies. They're always afraid that the limit will keep out the fellow with the really brilliant idea. But today they speak of a dollar minimum because that's something everybody understands.

Well known administrators, like Percy Hobson, Director of Stanford's Research Institute, say we should double our present effort and spend anywhere from $350 to $400 million a year. The figure you hear more and more: 10 to 15 percent of the annual research budget.

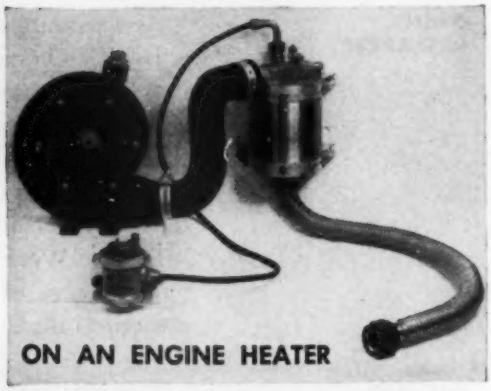
Need for funds in research has increased with the quickened tempo of

(*Continued on page* 137)

CMH FLEXIBLE METAL HOSE answer to 1001 design problems . . .

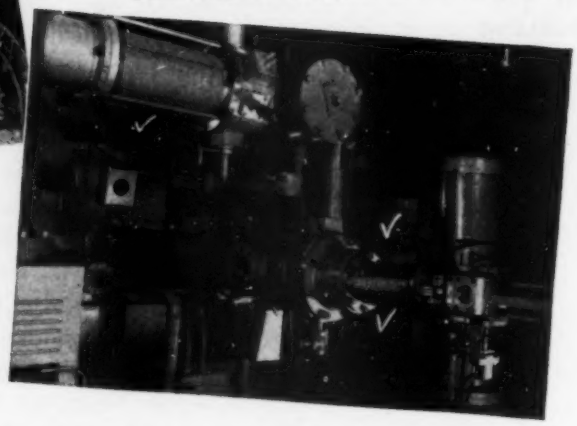


ON A JET ENGINE
(Photo courtesy, General Electric Co.)



ON AN ENGINE HEATER

ON A RECORD-HOLDING RACE CAR
(Photo courtesy, Cummins Engine Co.)



ON A POSITIVE ION ACCELERATOR
(Photo courtesy, High Voltage Engineering Corp.)

The Flexible Metal Hose Design Guide gives detailed data on types, sizes and characteristics of CMH hose. Write for your copy today, or see complete hose specifications in Sweet's Product Design File.

In any product where liquids or gases must be conveyed under conditions of vibration, expansion and contraction, misalignment or flexation, there is a design problem that can be answered with CMH Flexible Metal Hose.

CMH Flexible Metal Hose is available in a variety of corrugated and convoluted types, in steel, bronze, stainless steel and other alloys and in a complete range of diameters for every application. Whatever your product, if motion or misalignment exists in fluid conveying lines, it will pay you to consider CMH Flexible Metal Hose. Just send an outline of your problem and we will make recommendations.

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Flexible metal hose

Expansion joints

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Metallic bellows

today's science. There was a time when a fundamental researcher needed only string, wax and a little ingenuity. But a nuclear physicist today, studying the behavior of radioactive particles, might need a million dollars worth of atom-smashing equipment before he starts his first experiment.

Another worry plaguing authorities is the small number of technicians currently in fundamental studies—less than 15,000 according to the National Manpower Commission. Proving you can't encourage people to do basic research if you have no place for them to work and no funds to use.

WHERE?

Traditionally universities and colleges have taken the lead in basic research. In recent years, some work is credited to individual privately endowed foundations like the Carnegie, Ford, and Rockefeller organizations. But government agencies, under Pentagon contracts, have been taking a bigger and bigger bite, while traditional sources have switched to applied research.

Universities prefer applied research because it pays better than any other kind. With deficits piling up, campus officials have been soliciting work from government and industry. Some have set up extensive foundations that will do the same type of work as a commercial testing laboratory. As a result the schools have neither the personnel nor facilities left for basic studies.

SHORTAGE OF PERSONNEL

Calibre of personnel is another controversial subject. Many scientists—particularly if they have a continental education—claim the U. S. colleges cannot train adequate personnel for fundamental research. Their major point: American institutions emphasize graduating the average student, rather than lifting the standards for the most talented group. As a result, they maintain, educational levels have slipped in this country. There's not enough intensive early age training in fundamentals.

WHO PAYS?

However, the biggest problem in basic research is who should pick up the bill. Industry—say a lot of people. They claim that much theoretical work eventually ends up supporting commercial processes and products. Industry has the largest stake in fundamental research, let them finance it.

Industry, on the other hand, will tell you they already support basic research—in their own laboratories and at their favorite schools. But technical men argue that this support is only forthcoming when economic times are good. When business is bad, fundamental research money dries up. It's hard to condemn companies for such an attitude. When profits are small or nil they can't justify heavy expenditures for projects whose successful completion have no practical or economic meaning.

THE ANSWERS

The answer, according to a growing number of well informed people, is tax legislation that encourages industry to support fundamental research. Present laws—more concerned with revenue than anything else—closely limit the size of deductions for such purposes.

The only other possible solution seems to be a healthy National Science Foundation, one adequately financed by government money, but free of politics and bureacracy. Most scientists agree that NSF has done a good job with its limited funds.

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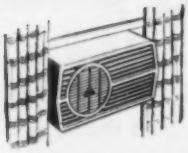
SPEED NUTS® give new Room Air Conditioner "Cool" 82% Assembly Savings!



Fedders-Quigan Corporation, Buffalo, plans Tinnerman SPEED NUT savings in design stages

● The results of this fastening engineering greatly reduced assembly costs—brought substantial production increases! Fedders engineers are now using 35 Tinnerman SPEED NUT brand fasteners per unit . . . an increase of 200 percent in the new models, a tribute to SPEED NUT success! Typical of the savings achieved by Fedders is the 82% reduction in the cost of attaching the Comfort Circle grille with a Cap-Type SPEED NUT.

Looking for ways to convert fastening problems into savings? SPEED NUTS will help! These high quality, spring steel fasteners are light weight, vibration-proof and self-retaining; eliminate welding, staking, riveting; can be used over welded studs; do away with threaded inserts. These are a few of the SPEED NUT advantages that will annually save thousands of production dollars for Fedders-Quigan!

See your Tinnerman representative for full information on our free, cost-saving Fastening Analysis service.

Cap-Type Push-On SPEED NUTS

Formerly a special clevis pin and lock washer were required to retain the spring coil and Comfort Circle grille as illustrated above. Now, Cap-Type Push-On SPEED NUTS press on by hand in *one* operation, lock with vibration-proof bite . . . for a big 82% savings!

Send for your copy of SPEED NUT "Savings Stories", an interesting booklet of Tinnerman savings to industry, write: TINNERMAN PRODUCTS, INC., Box 6688, Dept. 12, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners Ltd., Hamilton, Ont. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S.A.—7 rue Henri Barbusse, Levallois (Seine).

Our Heritage of Negation

PERHAPS THE FIRST WORD UNDERSTOOD by the baby crawling into mischief is "No! No!" or "Don't!", or its equivalent in other tongues. Perhaps this explains why the negative approach to teaching and understanding is used so commonly. "Don't" is the first word in many instructions.

Because the negative attitude is the first one taught, in many people it becomes ingrained in their thinking. Its ramifications are manifold. Not only does the confirmed negationist say "No" to almost every statement he hears, but also his instructions are usually predominantly "don'ts". And in viewing or studying the accomplishment of others his mind dwells mainly on the defects and shortcomings that he observes. These may be but mere specks and yet in his mind they are so big that they cover and hide the meritorious qualities at which he is staring.

Ironically, in many instances the attempt to teach or clarify something by the negative approach is hopeless. There are many more ways of doing a thing wrongly than doing it correctly. There are innumerable wrong ways to swing a baseball bat or a golf club or to kick a football or to cast a fishing line. The "don'ts" in doing any of these would fill a sizeable volume, whereas detailed instructions on how to do it correctly would cover only a few pages. Also, the beginner will always figure out a few more wrong ways that the author had failed to mention.

When attempting to learn by concentrating on the "don'ts" the mind gets filled with uncertainties. The student who has been given only the "don'ts" will always wonder whether or not there are some that he has forgotten or which he has not been told. On the other hand, the student who is instructed "how to do" has little trouble in memorizing the instructions and will be confident that his only requirement is to master the rules given him. Thus, in his practicing he will at least be trying intelligently to perform correctly.

This same philosophy applies to many of our other activities. The project engineer, the chief engineer or other engineering executive who is giving instructions should give them in the form of positives rather than negatives. And by the same token, the man who is listening should concentrate on the positives. And whenever an engineer is attempting to analyze the layout or design originated by a competitor, associate or subordinate, again mental emphasis should be on the positive attributes which he should seek to uncover. The negatives will stand out glaringly to the exclusion of the good points, if his thinking is not constructive and his mind is not open.

People with open minds are positive, not negative. They are the creators and leaders in progress. They are the doers who forge ahead. Their actions are studied and confident; their decisions and directives are constructive.

George F. Jordenkolt

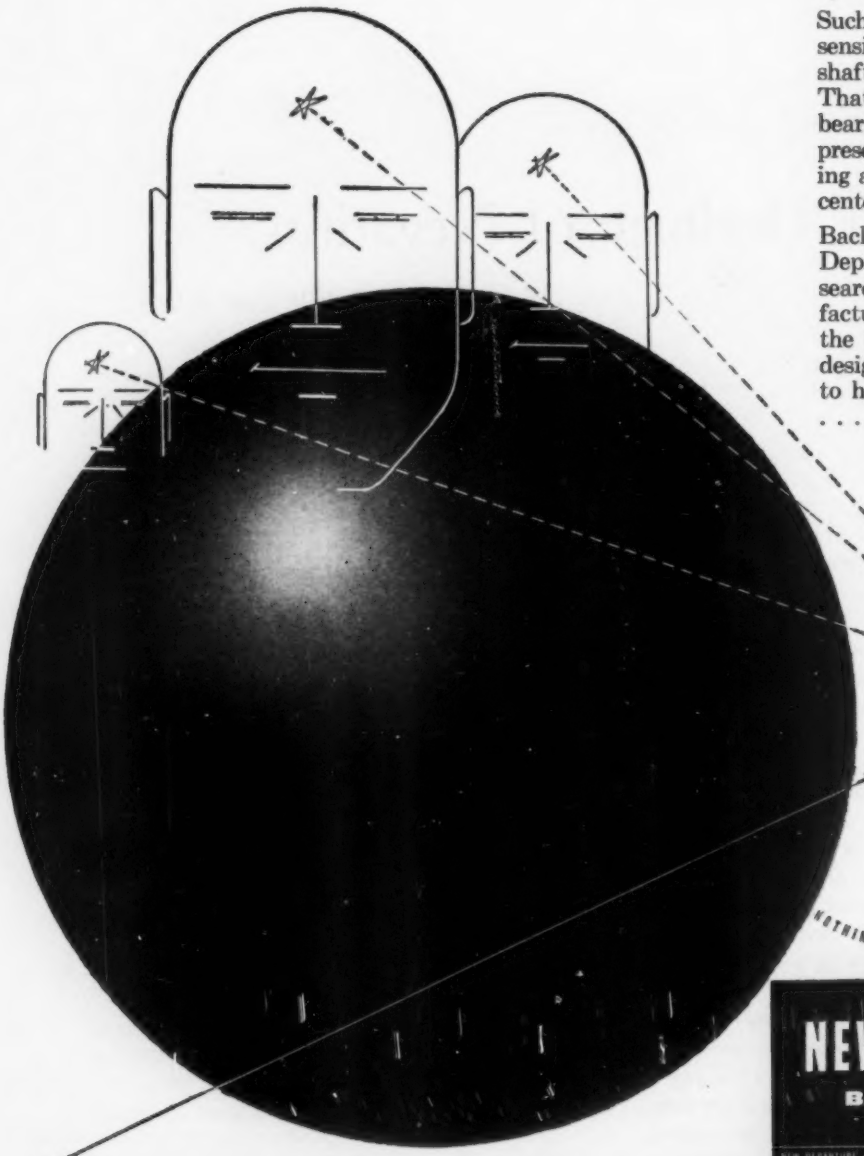
The BRAIN ...

has an № degree

One man, using a desk calculator, would work seven years on the problem this IBM "701" electronic computer solves in just a *few minutes!* In fact, this "brain" averages 14,000 mathematical operations *per second!*

Such lightning results call for sensitive, accurate support of shafts and other moving parts. That's why New Department ball bearings have the assignment of preserving alignment in the reading and recording devices at the center of the "memory" system.

Back of the newest of New Departure applications are research, engineering and manufacturing facilities unequalled in the industry. They are at the designer's and builder's disposal to help better present products . . . develop new ones.



International Business Machines' new "701" electronic computer employs New Departure ball bearings for mounting the magnetic drum rotors, as well as the magnetic clutches of its tape readers and recorders. All units of the calculator are shown at left.

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Also Makers of the Famous New Departure Coaster Brake

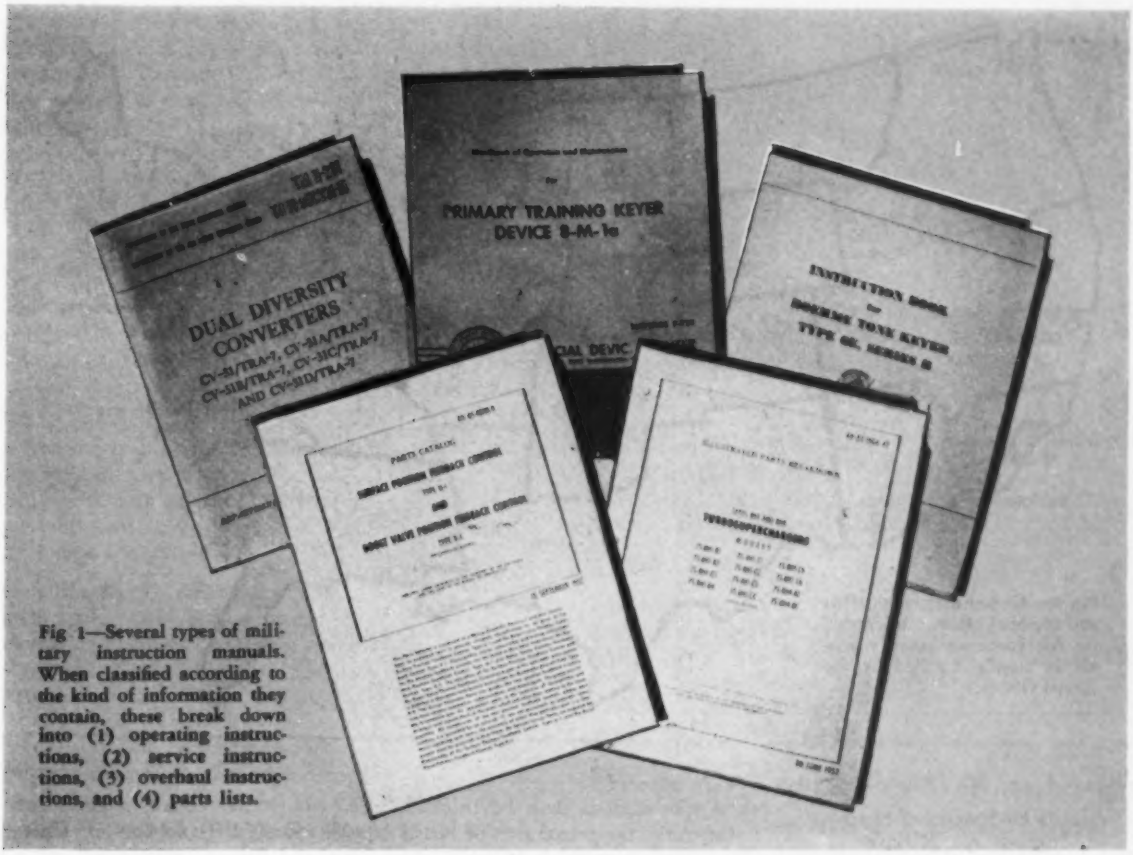


Fig 1—Several types of military instruction manuals. When classified according to the kind of information they contain, these break down into (1) operating instructions, (2) service instructions, (3) overhaul instructions, and (4) parts lists.

Instruction Manuals

. . . they're necessary for industrial equipment, required for military gear, often demanded by the sales department. Here are the requirements for acceptable manuals whether military or commercial, and methods of producing them at reasonable cost.

JOHN W. WIGHT
General Manager, Technical Writing Service, McGraw-Hill Book Company

AFTER EQUIPMENT has been designed and built, it must be operated and maintained. The reputation of the manufacturer often depends on how well these latter functions are performed. Yet operating and maintenance personnel frequently have only a minimum of technical knowledge, and are far removed from the engineering department.

To bridge this gap the designer must rely on an instruction manual. A good instruction book insures that the operator will get maximum effectiveness and rated life from the equipment. A poor one may cause mishandling, inadequate maintenance, and eventual loss of sales.

Requirements of Military Services

Most manufacturers are faced with the production of two types of manuals, military and commercial. Although the same overall techniques may be applicable to the production of both, (1) the objectives of the manuals may or may not be the same, and (2) specific requirements have been established by the military and

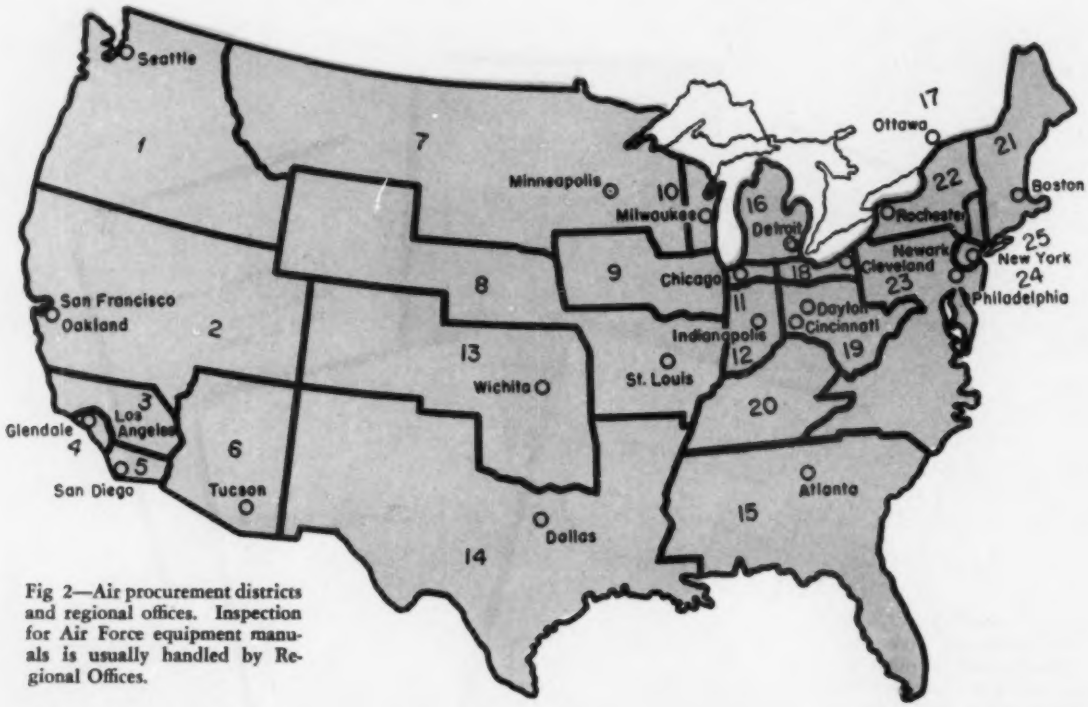


Fig 2—Air procurement districts and regional offices. Inspection for Air Force equipment manuals is usually handled by Regional Offices.

Table I—Sources of Specifications for Military Instruction Manuals

AIR FORCE
Commanding General
Air Materiel Command
Wright-Patterson Air Force Base
Dayton, Ohio

ARMY—*Ordnance Corps*
Commanding Officer
Publications Division
Raritan Arsenal
Metuchen, New Jersey

ARMY—*Signal Corps*
Commanding Officer
Signal Corps Procurement Agency
Philadelphia, Pa.

NAVY—*Bureau of Aeronautics*
Commanding Officer
U.S. Naval Air Station
Johnsville, Pennsylvania

NAVY BUSHIPS—*Electronics Publications*
Bureau of Ships
Electronics Division
Department of the Navy
Washington 25, D. C.

Other Navy Publications Specifications
Bureau of Supplies and Accounts
Department of the Navy
Washington 25, D.C.

Specify title and identifying number or symbol when requesting specifications.

these specifications must be fulfilled.

Currently, the preparation of nearly all military instruction books is the responsibility of the manufacturer, and requirements are specified in the initial equipment contract. A not uncommon contractual arrangement is that no payment can be made for any equipment until all requirements have been fulfilled, and this is always interpreted to include the delivery of instruction books.

Each branch of the military services has different requirements, not only in the types of manuals they require but in methods of presentation, inspection procedures, and other conditions of acceptance. The following discussion of these requirements has no official status, of course, and deals only with general conditions to which there are many exceptions. Nevertheless, it is representative of the current status, and can be used as a guide subject to checks with the cognizant military agency.

Department of the Air Force

Air Force instruction book requirements can be classified according to the type of equipment.

Test equipment. Usually requires two publications, a Handbook of Operating and Service Instructions and a Parts Catalog.

Electronic equipment. Needs four publications: Handbook of Operating Instruction, Handbook of Service Instructions, Handbook of Overhaul Instructions, and a Parts Catalog.

Other equipment. With the exception of aircraft and aircraft engines, requires three books: Handbook of Operating and Service Instructions, Handbook of Overhaul Instructions, and a Parts Catalog.

Simple equipments. Frequently covered by a single publication that is a combination Handbook of Overhaul Instruction and Parts Catalog.

Parts Catalogs also are known as Illustrated Parts Breakdowns.

The contents of all books are governed by detailed specifications, but overall requirements, especially in regard to format, are controlled by MIL-H-5474A, a specification covering general preparation of handbooks.

The normal final form of a contractor-furnished handbook is reproduc-

tion copy ready for photo-offset printing. Sometimes, only the manuscript is required if the information is to be incorporated in a larger, more comprehensive publication. If considerable revision is expected to include equipment design changes, photo-offset negatives are made for Air Force printing purposes and the contractor retains the reproduction copy.

Air Force publications inspection is usually handled by the Maintenance Data Sections of Regional Offices of the Air Materiel Command, Fig. 2, twenty-five of which are located throughout the United States.

Department of the Army

The two branches of the Army that procure the most equipment instruction books through manufacturers are the Ordnance Corps and the Signal Corps.

Ordnance Corps. This corps uses a multi-book system for its equipment literature, the usual breakdown being Operator's Technical Manual, Maintenance Technical Manual and Supply Catalog. The Operator's Technical Manual furnishes operation and maintenance information for using troop organizations, with discussions limited to removal and replacement of component assemblies, cleaning, lubrication, adjustment and minor repair. Tactical operating instructions are not included.

The Maintenance Technical Manual offers a higher level of maintenance information, including repairing and rebuilding within limitations of field and depot maintenance organizations.

Parts information is provided in the form of Supply Catalogs known as *SNL's* (Standard Nomenclature Lists). There are three types of *SNL's*: *ORD* 7, a list of replacement parts available to the using arm; *ORD* 8, for field and depot maintenance organizations; and *ORD* 9, a more comprehensive and generally complete list of all parts of the equipment. Sometimes *ORD* 7 is eliminated or combined with *ORD* 8.

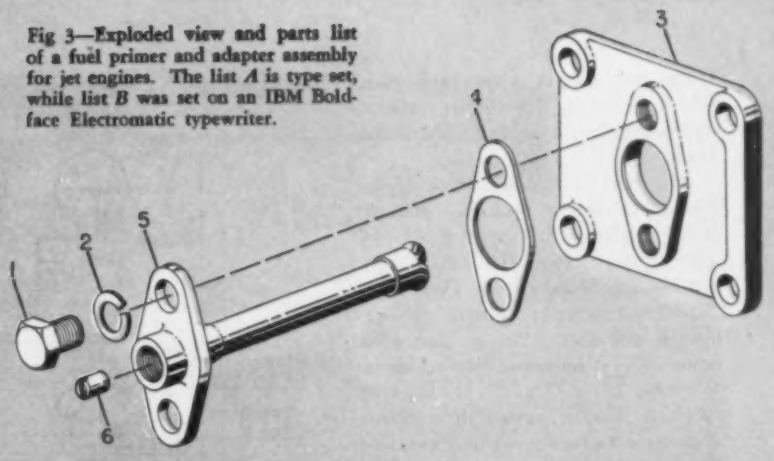
The Ordnance Corps has compiled an extensive series of *RA PD* (Raritan Arsenal Publications Division) specifications covering Ordnance technical publications: *RA PD 1A*, which contains general instructions for the preparation of technical publications for ordnance material; and *RA PD 1B*, which includes general instructions for the preparation of illustrations. Detailed specifications for specific types of equipment are numbered *RA PD 2*, *RA PD 3*, and so on.

The final form of contractor-furnished instruction book material is a typewritten manuscript and reproducible illustrations. The number of copies of manuscript and illustrations required varies with the type of book being prepared.

Inspection and approval of contractor-prepared publications is handled through the Publications Division of Raritan Arsenal, Metuchen, New Jersey, with the exception of automotive equipment books, which come under the jurisdiction of the Detroit automotive arsenal.

Signal Corps. The Signal Corps usually combines operating, maintenance, repair, and parts identification information in a single publication, titled Instruction Book, that is an unofficial Technical Manual (TM). Most instruction books are issued in a revised form as official technical manuals. When desirable, the Signal

Fig 3—Exploded view and parts list of a fuel primer and adapter assembly for jet engines. The list *A* is type set, while list *B* was set on an IBM Boldface Electromatic typewriter.



A ***Exploded View of Fuel Primer and Adapter Assembly***

Figure & Index No.	Part Number	Nomenclature 1 2 3 4 5 6 7	Units Per Assy
2–	C-9058	Fuel Primer and Adapter Assembly....	1
–1	A-9120	. Screw – Mach, hex hd, 0.250–28 NF3	2
–2	A-9121	. Washer – Spring lock, 0.267 in. ID X 0.057 in. thk, stainless steel....	2
–3	C-9118	. Plate – Adapter	1
–4	ASD–12219	. Gasket	1
	B–9119	. Primer Assembly – Fuel.....	1
–5	B–11333	. . Primer	1
–6	A–9123	. . Strainer	1

B **Exploded View of Fuel Primer and Adapter Assembly**

Figure & Index No.	Part Number	Nomenclature 1 2 3 4 5 6 7	Units Per Assy
2–	C-9058	Fuel Primer and Adapter Assembly. .	1
–1	A-9120	. Screw - Mach, hex hd, 0.250-28 NF 3.	2
–2	A-9121	. Washer - Spring lock, 0.267 in. ID X 0.057 in. thk, stainless steel.	2
–3	C-9118	. Plate - Adapter	1
–4	ASD-12219	. Gasket	1
	B-9119	. Primer Assembly - Fuel	1
–5	B-11333	. . Primer	1
–6	A-9123	. . Strainer.	1

Corps may specify a two-book plan, which removes the higher echelon maintenance to a separate instruction book.

The basic specification for Signal Corps instruction books is *MIL-M*-10953 (SigC), supplemented by general specification *SIG* 730-1, Preparation of Manuscripts. Part 1 of *SIG* 730-1 describes general requirements, and Part 2 covers illustration standards. Additional detailed specifications, titled Topical Outlines or Writing Guides, establish contents requirements for the various kinds of Signal Corps equipment. (Instruction Books smaller than 10 pages are generally issued as Instruction Sheets.)

The contractor is usually required to prepare a Tabular List of Parts (*TLP*), in accordance with specification (*MIL-T*-10186SigC), covering parts considered renewable. Standard hardware must be included for some types of equipment. The *TLP* is eventually recast and used in the instruction book as an Identification Table of Parts (*ITP*).

Most Signal Corps instruction books are furnished by the contractor as printed copies in accordance with requirements of the Signal Corps Printing Style Book. Publications inspection and approval are the responsibilities of the Signal Corps Publications Agency at Fort Monmouth, New Jersey.

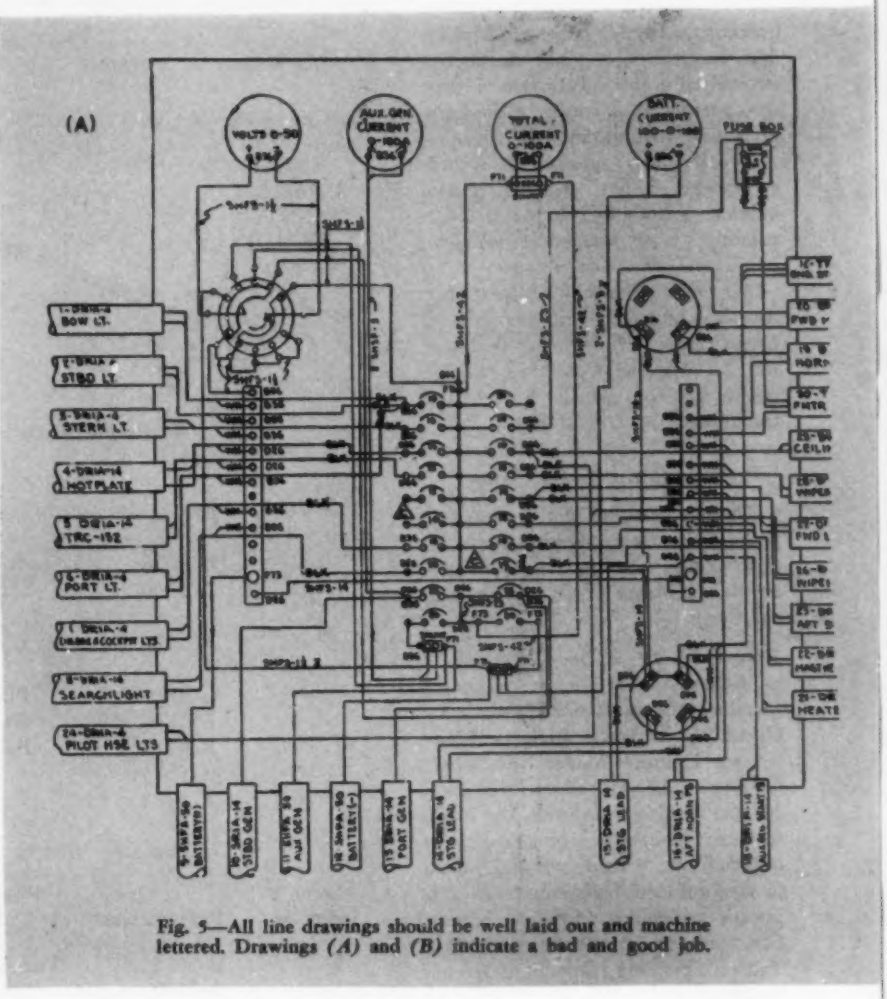


Fig. 5—All line drawings should be well laid out and machine lettered. Drawings *(A)* and *(B)* indicate a bad and good job.

Department of the Navy

Navy branches that procure the most equipment instruction books are the Bureau of Aeronautics, Bureau of Ships and the Bureau of Ordnance. BuAer requirements are similar to those of the Air Force. They usually use the same series of specifications. Inspection procedure differs, however, in that a central section in Washington, D. C., handles it.

The majority of contractor-furnished BuShips instruction books can be divided into two categories: those for electronic equipment and those for equipment primarily mechanical. The preparation of electronic instruction books is governed by BuShips Specifications 16*B*16 (*RE*). Books prepared to this specification include all description, theory, installation, operation, service, maintenance, and parts-identification information in one publication. The contractor is normally required to carry the preparation through to printed copies.

For mechanical equipment, books prepared in accordance with Specification *MIL-B*-15071 (*SHIPS*) are usually required. Again, as with 16*B*16, all equipment information is published in one book, which the contractor must furnish in printed form. Existing commercial instruction books are acceptable for *MIL-B*-15071 under certain conditions. The Bureau of Ships, in Washington, generally handles inspection and approval.

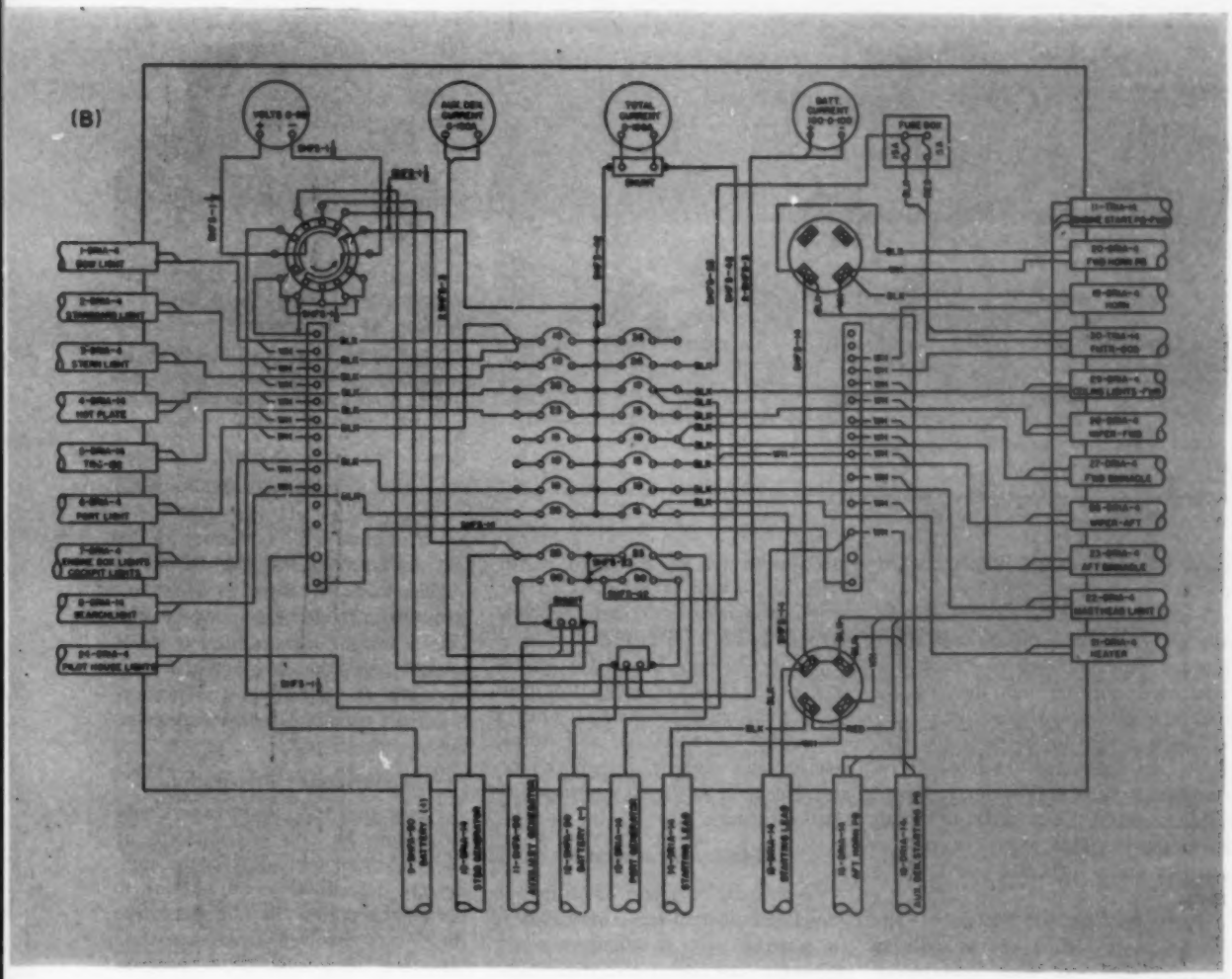
It is quite likely that both 16*B*16 and *MIL-B*-15071 will be superseded by new similar specifications before long.

The Bureau of Ordnance requirements are generally the same as those of BuShips except that the reproduction copy is frequently the contractor's end product. The basic specification is OP1, Preparation of Ordnance Publications. Inspection and approval is handled at the Bureau level in Washington.

Table I lists specification sources for the military services.

Types of Instruction Books

There is no good breakdown for types of instruction books. There are, however, general classes of information regardless of whether manuals are furnished separately or combined into a single publication. These broad classifications are based largely on the relative caliber of maintenance to be performed. On this basis, there are three types: operating instructions, service instructions, and overhaul instructions. In addition, there is another classification, parts lists, which usually is associated closely with overhaul instructions, and a fifth category dealing with development equipment.



(1) Operating instructions should include sufficient theory and principles of operation, to enable the operator to gain a fundamental understanding of how to use the equipment.

Operation limitations and precautions should be included, as should also reference to any adjustments, checks, maintenance, or emergency repairs that can or should be performed by the operating personnel. It is well to bear in mind that operating personnel may not have a high level of technical training nor have access to the tools and equipment necessary for major repairs and maintenance.

For some devices, proper warm-up and shut-down procedures are essential operating information. Inspection practices, cleaning, preservation, and lubrication methods also should be discussed.

(2) Service instructions generally cover organizational and field maintenance. Field maintenance is performed by maintenance personnel who directly support the using organization. This latter class of maintenance is limited primarily by the tools and maintenance equipment available in the field. Malfunctioning or unserviceable parts and assemblies are not normally replaced, but are sent to an overhaul depot or shop for repairs.

Testing and adjustment of equipment within the scope of organizational maintenance are also included. Because of the similarity of service instructions and the operator's instructions, they are generally found in the same book.

(3) The purpose of the overhaul instructions is to provide detailed information for a major overhaul or the complete rebuilding of equipment. Overhaul shops have more specialized skill and equipment than field forces.

Instructions for mechanical equipment generally should utilize exploded views from the parts lists to supplement detailed text on disassembly and reassembly. Parts in exploded views should be numbered according to the sequence of disassembly to facilitate the text explanation. Also, most overhaul instructions specifications require extensive testing procedure coverage to insure that the equipment is in good operating condition after overhaul.

(4) The primary purpose of a parts list is to locate and identify parts for replacement purposes. Some specifications require identification, description, and illustration of all parts; others do not require coverage of standard items such as common bolts and nuts. Nearly all specifica-

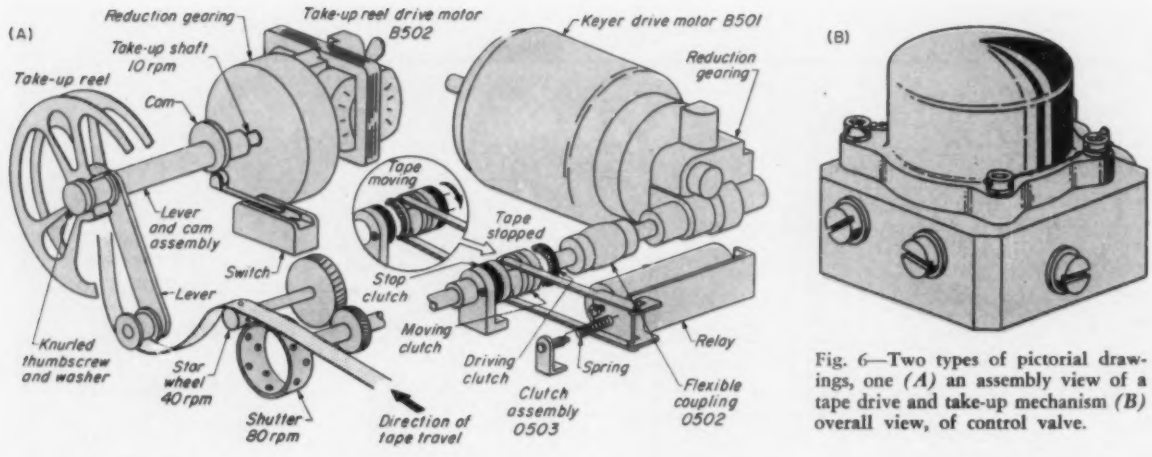


Fig. 6—Two types of pictorial drawings, one *(A)* an assembly view of a tape drive and take-up mechanism *(B)* overall view, of control valve.

tions, however, require illustration of parts.

Parts of mechanical equipment usually are shown in exploded-view illustrations depicting each part in a disassembled position but showing its relative position in the assembly.

The first item in the parts list, Fig. 3, is the complete assembly. The component parts follow in the order of disassembly. Quite often, attaching hardware is listed after the part it attaches and is identified as Attaching Parts.

Part numbers are those of the manufacturer. Some of the military agencies also ask that government stock numbers be shown for the parts, in which case the manufacturer may be required to submit complete descriptions and drawings of the parts involved to the numbering agency.

Parts and assemblies are indented in the nomenclature column to show the relative level of assembly. For example, the Primer (-5) in Fig. 3 is indented one space to the right of the Fuel Primer Assembly (-4) to show that it is a part of the Fuel Primer Assembly. The fuel primer assembly, part number B-9119, includes the primer, but the primer, part No. B-11333, also may be procured separately.

Electronic equipment parts list specifications often do not require exploded views or coverage of standard hardware. Photographs of the chassis with all parts intact are used for identification of functional electronic parts. The reference symbol or part number is shown in the illustration. Full parts information can be presented in the parts list, which is arranged in the order of symbol reference or parts number as the case may be.

(5) Instruction books for prototype or development equipment generally represent a special case. Only a few copies are necessary, and format requirements usually are much less stringent than for books covering production items.

Commercial Manuals

Commercial operating or instruction books and maintenance manuals have the same objective as military manuals, although—depending on the complexity of the equipment—the breakdowns may not be so fine insofar as handbook classifications are concerned. As a matter of fact, a users instruction manual and a serviceman's maintenance manual may not always be required; sometimes the two books can be combined into one. However, parts replacement information is usually necessary in commercial manuals.

The same techniques and requirements generally apply to manuals for industrial or consumer equipment as to military manuals. Perhaps more elaborate presentation is necessary, since the manual should become an effective selling tool. Well-presented instructions not only enhance a manufacturers reputation, but convince the customer that the manufacturer wants to help him get maximum value for his purchase.

Because of their value as sales aids, commercial manuals are often printed in several colors.

Preparing the Manual

There are two ways in which instruction manuals can be prepared. One is for the manufacturer to do it himself; the other is for him to contract for its preparation and production from outside companies specializing in such services.

Manufacturer Preparation

Preparation of instruction books can rarely be done satisfactorily if assigned to an individual in the engineering department as an addition to his regular duties. In addition to the time factor involved, close association with the equipment often prevents the objective viewpoint necessary when writing for a different level of technical knowledge or aptitude. The task should be performed by competent engineering writers and illustrators headed up by responsible personnel.

A comprehensive analysis of the job is a must before starting work. There are seven pre-writing steps that must be taken, as follows:

1. Determine fully the contractual requirements.

2. Gather all of the available source matter, including all applicable specifications and up-to-date equipment data and arrange it in an orderly manner for easy reference. If the equipment is in the development stage, arrange to receive notification of design changes.

3. Read and understand clearly the specifications. Costly errors can be avoided by complete familiarization and understanding.

4. Study the equipment and prepare a systematic breakdown of the assembly and sub-assembly components (make certain the breakdown is compatible with military requirements). It is usually a good idea to do the parts list first, since the parts information is needed for writing the other material. Do not forget supplementary equipment such as accessories, test equipment, special service tools, and connecting cables. A component breakdown not only helps to establish a presentation sequence but also in making a comprehensive evaluation of the job ahead.

5. Prepare a detailed outline; a good instruction book cannot be written without one.

6. Check with the military inspector (if possible). He welcomes the opportunity to discuss the book before actual writing starts. Such discussion invariably saves time, trouble, and money.

7. Establish a schedule and budget. A schedule sets a series of mileposts or checkpoints for evaluating job progress. Assign target dates for the completion of each of the phases so that the final delivery date will be met, and include a contingency factor in the schedule for the unforeseen developments that always happen.

The same principles apply to a budget. Make equitable allocations in hours (or in dollars if cost-accounting service is available) for each operation. Keeping job cards or sheets for each operation, on which time is recorded, is a convenient means of checking time expenditures. It cannot be emphasized too strongly that, as with the schedule, contingency allowances must be included in budgeting.

The actual writing is not simple. Good technical writing is more than skimming through subject matter and setting down points that occur to the writer. Good writing comes only from much study and careful consideration of the eventual user, and thorough organization of material. See Table II for suggestions on writing and illustrating.

The need for understanding a typical, eventual user is fundamental. All information must be presented at his reading level. The reading level for instruction books generally should be for that of a second-year high school student. A typical user also can be ex-

Table II—Tips on Writing, Illustrating, and Producing Technical Manuals

WRITING

1. Use short sentences.
2. Use short paragraphs and separate paragraphs for each thought.
3. Give specific instructions. Statements such as "test in accordance with authorized shop procedure" are worthless unless the source is given.
4. Avoid uncommon words or unnecessary technical phraseology.
5. Avoid complicated phrasing. Delete superfluous words.
6. Use exact nomenclature. Name each part, component, or subassembly. Do not use such references as "the unit."
7. Divide the text by appropriate headings and sub-headings.
8. Tie in discussion and illustrations so that one follows closely on the other.
9. Edit the manual. As teaching devices manuals deserve proper presentation.

ILLUSTRATING

Photographs

1. Photographs may be used for equipment views, operational views, and parts identification.
2. Photographs usually require retouching to retain detail sharpness.
3. Omit superfluous or unattractive backgrounds by cropping and retouching or opaquing.
4. Use "exploded" views to identify parts in mechanical assemblies and assembled chassis views for electronic equipment.
5. Identify parts by number, reference symbol, or name on the picture.
6. For identification nomenclature use copy prepared by typesetting or with mechanical lettering guides.
7. Plan each picture, and supply the photographer with a rough layout so each view covers required subject matter.

Airbrush Renderings—Costly. Use for phantom or cutaway views only.

Wash Drawings—Restrict these primarily to site or frontispiece illustrations.

Line Drawings—Restrict these primarily to site or frontispiece illustrations.

1. For wiring diagrams and electrical schematics use consistent practices on symbols, line weights, conventions, and layouts as recommended by the military service involved. (Fig. 5)
2. Use mechanical schematic drawings to illustrate operating features and maintenance practices. Present hydraulic, pneumatic, and mechanical drive systems in schematic form.
3. Specify plan views to show installation and mounting features, lubrication practices, equipment outlines and dimensions, and panel markings.
4. Simplify the job of explaining operating and maintenance details by liberal use of pictorial drawings, Fig. 6. Isometric projection is common, but dimetric and trimetric projection gives the subject a more natural appearance. Shade them when it will add realism.
5. Use exploded views in conjunction with parts lists to show assembly and disassembly procedures. Use pictorial drawing technique.
6. Limit the use of color to functional purpose such as flow diagrams, etc.

PRODUCTION

1. Type the manuscript double-space on white paper. Leave wide margins, and adhere to precise standards on punctuation, format, and style.
2. Proofread each typed copy for accuracy; usually a rough draft, approval draft, and final draft are necessary.
3. Mark the final draft for type, spacing, and make-up. Make all changes and corrections in the manuscript prior to starting final typography.
4. Make certain that the index, contents pages, title pages, appendix, and other data are supplied with the manuscript.
5. Schedule printing well in advance to insure delivery when required.

Table III—Estimating Manual Cost

Writing

Include time for research, outlining, several drafts, illustration planning and checking, any travel and liaison time that may be required, and overall project supervision and handling.

Editing

Most jobs require more than one editing. The usual changes and additions after the original editing make the allowance for two complete editings realistic.

Illustrating

1—Halftones	2—Line drawings
Photographer's time	Pencil layout
Opaquing and retouching	Inking
Nomenclating	Shading
Checking	Checking

Production Costs

Typing. Include at least three complete typings plus an allowance for making corrections.

Proofreading. Allow for proofreading each typewritten draft and the final typography.

Final typography. Costs here include marking for compositor, making pasteup dummy, and necessary liaison with compositor and printer. Secure typography cost estimate from a compositor unless operation is internal.

General clerical work. Preparing review copies and maintaining drawing files are examples.

Printing. Establish requirements and get quotes from printer. Consider shipping costs.

Other Direct Costs

Reproduction Costs. These include cost of blueprints, photostats, photographic negatives and prints, and any other costs of reproduction necessary during the preparation of the illustrations.

Travel costs. Include fares, subsistence and other likely costs if liaison and travel are necessary.

Indirect Charges

The charges in this category are those that are general organization expenses not directly chargeable to any one job. Rent, for example, is usually pro-rated over all jobs. Expenses of this sort are normally included in overhead. The method of application to projects varies. Overhead should be recognized, however, as an actual expense.

pected to have a minimum of technical background and no previous experience with the equipment involved. Overhaul instruction book readers may be presumed to have considerably more technical background with other equipment, but none with the particular equipment.

Technical Writing Services

During World War II, the pressure of war contracts and the trend to specialization encouraged the growth of firms specializing in the preparation of technical literature. Some were set up by ex-members of manufacturers' publications departments; others were developed from engineering, art services, publishing, advertising and other backgrounds.

Typical of the larger writing services are the Philco Corporation Technical Publications Department, Cushing & Nevell and the Technical Writing Service of the McGraw-Hill Book Company.

Most of these firms undertake an entire job or do those parts of a job that a manufacturer is not staffed or equipped to handle. They maintain staffs of specialists—engineering writers, technical illustrators, and technical editors—experienced in the preparation of government and commercial technical literature.

As with purchasing any other service or material, a manufacturer should thoroughly investigate the capabilities of a writing organization before placing an order. A reliable writing service does a job right the first time and produces a better book without price re-negotiation. A good firm also requires a minimum of liaison with manufacturing personnel.

Clear-cut contractural conditions must be established between the writing firm and the manufacturer to define the scope of work to be done. Operational details covering the review procedures and the handling of additional charges for design changes are typical examples of potential misunderstanding.

Cost Estimating

In making a cost estimate, the following factors must be determined:

1. What does the source material consist of?
2. What is the end product?
3. What is the probable size of the project in terms of manual pages, illustrations, trips, etc.
4. What will the operating conditions be? This includes review procedure, schedule, and probability of design changes.

The best approach to cost estimating is to break down the job into easily recognizable units and estimate the unit costs. Establishing unit costs for typing a page of manuscript or retouching one photograph is a much more manageable proposition than trying to estimate the entire job.

To do this requires a thorough analysis of the job to arrive at the quantitive values for the text and illustrations. An added advantage of this analysis is that it provides an approximate job plan for the work.

It is extremely desirable to use an estimating form or checklist Table III for compiling costs. Otherwise, it is all too easy to overlook specific operations.

The Security Problem

The different security classifications in ascending order are: Restricted, Confidential, Secret, and Top Secret. Very few instruction books carry the Secret or Top Secret classification.

Each classification requires different handling methods, which are described in a pamphlet titled "Industrial Security Manual for Safeguarding Classified Matter" prepared by the Office of Manpower and Industrial Security, Munitions Board, Department of Defense. It may be obtained through the contracting officer.

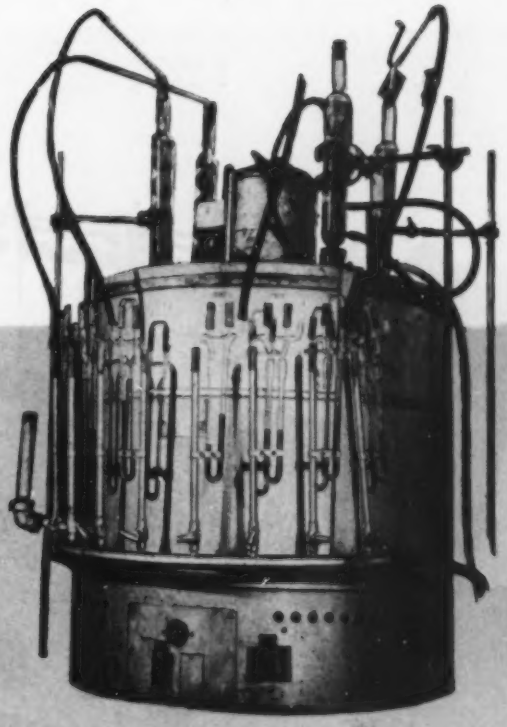


Fig. 1—Indiana oxidation test for determining the comparative resistance to breakdown of petroleum fluids.

Which Characteristics for HYDRAULIC FLUID?

The service requirements of hydraulic fluids in present day systems are both complex and severe. Here are some of the basic facts covering types and characteristics that will help the designer to select the right fluid.

B. B. FLICK
Lubrication Engineer
E. F. Houghton & Company

THE FLUIDS USED in hydraulic power and control systems fall in three classifications: water, petroleum oils, and nonflammable synthetic fluids. The petroleum oils, in either their natural state or else treated with additives, will satisfy most requirements, while water and the synthetic fluids are used in applications where their unique properties are necessary for proper system operation.

The selection of the proper hydraulic fluid for a specific application depends on such things as component clearances, component materials, leakage, operating temperature range, ambient conditions, system design, pressure range, fire hazards, and the cost of the fluid. The properties of the petroleum oils are such that these fluids will satisfy most of the normal requirements; if not in the natural state, at least by the use of the correct additives or inhibitors. Water and the nonflammable fluids are used in the special applications where leakage or disposal rates are high or where the fire hazard is great.

This follows from the fact that although water has certain unique characteristics, many of its properties do not meet the specifications required of a good hydraulic fluid. Thus, water has certain advantages when used as a fluid power and control medium. These are: wide availability, low cost, constant viscosity characteristics, and nonflammability. It is a good hydraulic fluid in large bulky installations where leakage is a factor, where there is an open system, or where the water is used for both the

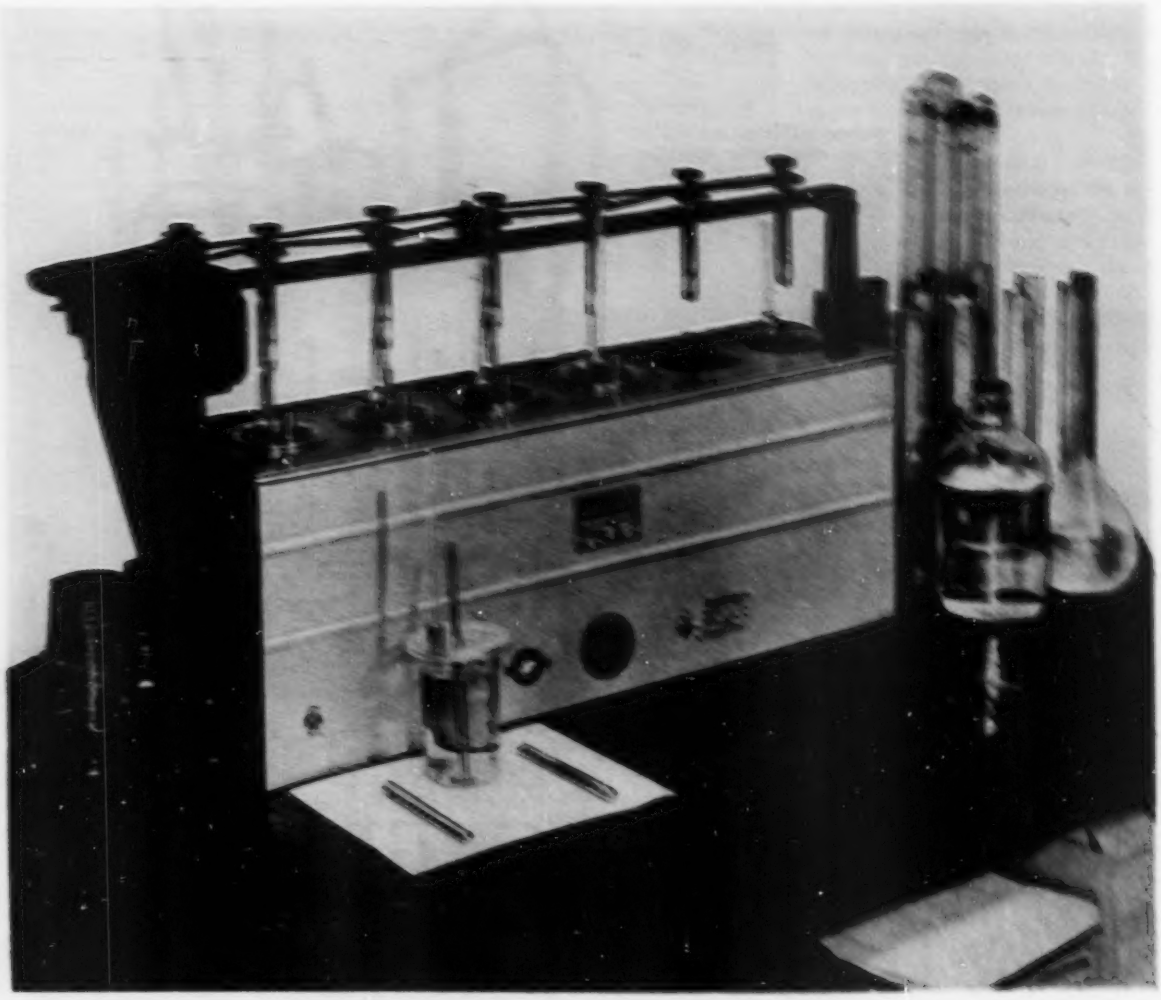


Fig. 2—Apparatus for running ASTM turbine oil rusting test.

hydraulic system and for cooling the work, as in large forging presses.

On the other hand, the disadvantages of using water greatly outweigh the advantages and are largely responsible for the acceptance of petroleum oil for hydraulics. Water will form scale, cause internal rusting, and has a high freezing point, poor lubrication qualities, and low viscosity.

Unless water is treated to prevent scaling, formations will build up and tend to clog lines and orifices, causing malfunctioning of the system.

Usually, water operated hydraulic systems cannot be subjected to temperatures below 32 F. This fact alone greatly reduces the number of its applications as a fluid medium since normally it cannot be used in outdoor equipment.

The poor lubricating quality of water is closely associated with its low viscosity factor. If leakage is neglected, the low viscosity characteristic results in low frictional resistance and a higher capacity per unit pump size than if the fluid had a higher viscosity. However, because of its poor lubricating qualities, it is necessary to design special equipment to handle water since the rubbing pressures between mating parts must be low. Conventional rotary and gear pumps are not normally used for pumping water.

Soluble oils can be added to improve the lubricity of water, reduce corrosion of internal parts, and lengthen packing life by imparting some degree of lubricity to the packing and preventing deterioration.

These oils must condition the water, off-setting the effect of acids and impurities. They must adhere to metal and form a protective coating to insure against the activity of rust forming impurities. They should be compatible with all types of packings used in water hydraulic systems and should give added life to packings through improved lubrication. And finally, they should lubricate all component parts.

Additives, Table I, are available that have been designed specifically for water hydraulic systems and which will satisfy these requirements. Certain ones can be used in proportions as small as one part lubricant to 1,000 parts of water. However, even with these additives, water is only used as a fluid medium when one of its unique properties is required. Some type of oil is the usual hydraulic fluid and serves as the fluid medium in the majority of hydraulically operated mechanisms.

Hydraulic Oils

The properties of any hydraulic oil are dependent on the type of crude from which it is made, the type and quality of additives which are used, and the manufacturing process. Thus, a wide range of hydraulic oils, as to type and quality, is available.

To distinguish one oil from another, specifications have been set up which give the physical properties of the oils based on certain tests that are met or passed by each particular oil. The list of specifications may include some or all of the following: 1. viscosity, 2. viscosity index, 3. gravity, 4. flash point, 5. fire point, 6. color, 7. pour point, 8. carbon residue, 9. demulsibility, and 10. neutralization number.

The specifications are indications by which the laboratory can determine, to a limited extent, the basic crude from which the hydraulic oil was refined. Specifications also help to determine how any oil will perform under given operating conditions by comparing its physical properties with those of a similar oil which has performed satisfactorily under identical conditions.

This is not the final answer in the selection of a hydraulic oil since specifications are only a part of the overall picture. There are certain functions that a hydraulic oil must perform that are not covered by physical specifications: These are:

1. It must protect the system against rust and corrosion.
2. It must adequately lubricate the working parts.
3. It must be stable.
4. It must be resistant to foaming or aeration.
5. It must be able to carry in solution common contaminates which are present in hydraulic systems.

Thus, to properly evaluate a hydraulic oil, it is necessary to consider the functions it must perform as well as the specifications. In common applications the three essential properties of a hydraulic oil are viscosity, lubricity, and stability. Although there are other desirable properties worthy of mention, these three factors are fundamental and should be considered first.

Viscosity is a measure of resistance to flow under standard conditions and is usually the most important property of a hydraulic oil. Regardless of what other desirable properties a hydraulic oil may have, it cannot be considered if it will not flow properly through the system under available pump pressure. In addition, the oil must have sufficient body to give an adequate seal between the various working parts of the hydraulic system and at the same time, it must not be so viscous as to cause pump intake cavitation or sluggishness.

The correct grade or viscosity is determined by several factors; size and type of pump, operating temperature, and pressure. The majority of hydraulic systems operate most efficiently on oils falling in the following viscosity ranges:

136 to 165 SSU at 100 F
185 to 230 SSU at 100 F
275 to 315 SSU at 100 F

Although some hydraulic equipment requires oils having lighter or heavier viscosity ranges, they are in the minority and can usually be treated as special cases. The oil supplier or pump manufacturer can furnish information as to the correct viscosity of hydraulic oil to be used and should be consulted before making a selection.

Next in importance to viscosity is the lubrication property of an oil. Present day pumps are manufactured as precision instruments. The mating or rubbing surfaces are highly finished and closely fitted to keep leakage at a minimum and efficiency high. Wear must be negligible if a pump is to maintain its original efficiency. Maintaining adequate lubrication in hydraulic mechanisms is difficult since internal pressures are present that are much greater than indicated gage pressure. For example, in external

Table I—Water Additives

1. Soluble petroleum oils
   Used in proportions of about 50 parts water to 1 part additive.
   Recommended where open systems are used and losses of fluid are great. Least costly of additives.
2. Soluble concentrates—(nonpetroleum)
   Used in proportions of 500 to 1000 parts water to 1 part additive.
   Recommended where closed systems are used and losses of fluid are negligible.
   Both types slow down rust formations and aid in the lubrication of rubbing surfaces.

Table II—Function of Additives for Hydraulic Oils

1. Film strength
   Increases factor of safety against pump wear.
2. Rust inhibitor
   Used in small percentages to prevent the formation of rust on the interior of reservoirs and internal parts of system.
3. Oxidation inhibitors
   Oil-soluble additive for retarding formation of sludge and gums in system. Such materials are formed through oil breakdown because of agitation, heat, air, pressure and the presence of various metals.
4. Gum solvency
   Used to impart added gum solvency to oil to help maintain clean system. Some straight oils will precipitate gumming products which cause sticking and hesitation of system components.
5. Viscosity index
   Reduces variation in oil viscosity with changes in temperature.
6. Anti-foam additive
   Increases the ability of oil to lose foam quickly.

Table III—Data Required When Ordering Oil From Hydraulic Oil Supplier

1. Name and type of equipment.
2. Name and model of hydraulic pump.
3. Name and type of filter in use (fullers earth, paper, cloth, metallic, screen).
4. Capacity of system in gallons.
5. If trouble has been encountered with present hydraulic oil, give details.

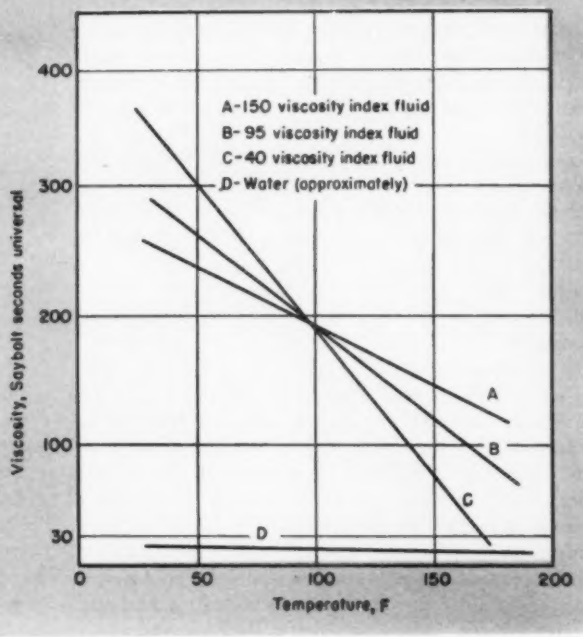


Fig. 3—Pictorial representation of viscosity behavior of oils of different viscosity index under changes in temperature.

gear pumps the oil trapped between the root of one tooth and the top of the mating tooth can be subjected to pressures far above the rated output pressure of the pump.

The film strength of straight mineral oils is limited and under extreme pressue conditions they do not give sufficient lubrication to prevent wear. Scoring of mating surfaces and even seizure followed by pump failure have resulted from the use of an improper oil. These conditions can be minimized or corrected by selection of hydraulic oils which contain film strength or lubricity additives.

Stability or lasting quality is another essential of a good hydraulic oil. This not only refers to the inherent qualities of the oil but also to the type of additive used to fortify the oil against deterioration effects. If an oil is to withstand the combined destructive effects of high pressures, heat, moisture, air, violent agitation, and catalyzation from contact with metal surfaces, it must have the proper chemical structure.

This structure of an oil refers to the natural oxidation inhibitors found in selected base stocks. Since some of these natural inhibitors are removed as the oils go through the refining processes, it is necessary to further fortify these oils against breakdown by the use of synthetic oxidation inhibitors.

There is evidence that a good oil can be made better through additive treatment, Table II; however, there is no proof that an inferior or unsuitabile oil can be transformed into a good oil by adding inhibitors.

In the past, the selection of incorrect oxidation stability additives has occasionally caused controversies as to the merit of additive type hydraulic oils. Today, however, nearly all pump and machinery manufacturers agree that carefully selected hydraulic oils, properly inhibited, are superior to straight mineral oils.

While stability is an important property, it is also a difficult one to determine. Expensive test facilities are required which are only practical in laboratories which specialize in oil analysis. Thus, the responsibility reverts back to the oil supplier and he must be able to furnish performance data and recommendations.

Although viscosity, lubricity, and stability are usually the most important properties, others of the previously listed specifications and functions are desirable and are obtainable in certain hydraulic oils.

While oils with a high oxidation stability usually remain free from corrosive action, quantities of moisture from condensation and contamination from water soluble coolants are usually present and rusting can occur.

Rust protection can be obtained by using a suitable rust inhibitor which will "plate out" on the metal surfaces and prevent corrosion without detracting from other desirable qualities of the oil.

Under severe service conditions, even the finest oils will eventually oxidize and form troublesome gums and resins. When the saturation point of the oil has been reached, these gums will deposit out on pump and valve surfaces. Certain types of additives will extend the saturation point of an oil so that it can be retained in service longer than an untreated oil.

Some oils will foam excessively either because of system design or because of the nature of the work being performed. The presence of certain additives can also cause foaming. For those applications where the entrance of air into the fluid is unavoidable, anti-foam agents will reduce excessive foaming.

Viscosity index, Fig. 3, is a measure of the effect of temperature change on the viscosity of an oil. A high viscosity index is a desirable property since it indicates an ability to withstand large temperature changes with relatively small variations in viscosity. In typical systems

a low viscosity index oil tends to cause a reduction in mechanical efficiency as the operating pressure is increased. However, a high index should not be specified if it involves a sacrifice of other properties.

The pour point is the lowest temperature at which an oil is fluid. Most pump manufacturers recommend an oil with a pour point 20 F below the lowest anticipated operating temperature. This is an unimportant property except for oils used in low temperature equipment.

Both viscosity index and pour point are closely associated with viscosity requirements and should be taken into consideration when selecting proper viscosities.

While the neutralization number is related to stability and is often used to determine the useful life of an oil, it is of little practical value with certain additive hydraulic oils. The use of additives and inhibitors affects the neutralization number to such an extent that it is not a dependable criterion.

Good demulsibility, or the ability to separate rapidly from water, is another desirable property of hydraulic oil. Unless the oil has this ability, there is danger of water-in-oil emulsions resulting in sluggish operation of equipment, acceleration of oil deterioration, loss of lubricating value, and eventual sludge formation.

Of the remaining properties, gravity, color, and carbon residue are of little direct value in selecting a hydraulic oil and are not usually considered.

The flash and fire points are of interest in the special class of fluids which are normally used because of their nonflammable property.

Nonflammable Fluids

While conventional petroleum hydraulic oils are satisfactory as the fluid medium for the majority of industrial applications, fires and explosions of the fluid in certain applications have always been a source of loss and casualty. With the use of hydraulic equipment over increasing ranges of operating conditions, these hazards have become more acute.

As a result, there has been a demand by industry and the military for synthetic hydraulic fluids possessing nonflammable or fire resistant characteristics. Several such hydraulic fluids have been developed and are being used with a limited degree of success.

These synthetic fluids cost more than petroleum oils because of the higher cost of raw materials and the complexity of manufacture. However, a nonflammable fluid which possesses the other required properties of a good hydraulic oil usually offers sufficient advantage to compensate for the high cost. Where the nonflammable property is an optional feature, cost should be one of the major factors which is considered in selecting a fluid.

Since the nonflammable synthetic fluids must perform the same functions as the petroleum oils, additives are normally used to furnish those desirable properties which are not characteristic of the synthetic fluids.

At the present time, the following base materials have been accepted as showing the most promise as nonflammable hydraulic fluids:

1. Phosphate ester compounds
2. Halogenated fluids
3. Water base fluids

The phosphate ester group of compounds has some of the properties that are essential to a good hydraulic fluid. In addition to their fire resistance, they have good lubricating qualities. However, the pour point is too high for some low temperature applications, and evidence indicates that they are not compatible with packing materials. Many of the difficulties encountered thus far are in connection with the special packing compounds necessary to handle this fluid and additional research will be required before these compounds are entirely satisfactory.

The halogenated group of fluids includes chlorinated and fluorinated compounds.

While the chlorinated fluids are almost nonflammable and are stable to atmospheric oxidation; like the phosphate ester they are not compatible with conventional packing materials. In addition, some of the chlorinated fluids give off toxic vapors that constitute possible health hazards and consequently make them undesirable for normal usage.

The fluorinated base fluids are more stable than the chlorinated base fluids, and it is possible that through the use of proper additives certain mixtures of fluorinated hydrocarbons can be developed that will prove satisfactory as a hydraulic fluid. However, as in chlorinated fluids, the disadvantages of toxicity and incompatibility with the commonly used rubber seals must first be overcome before this can be achieved.

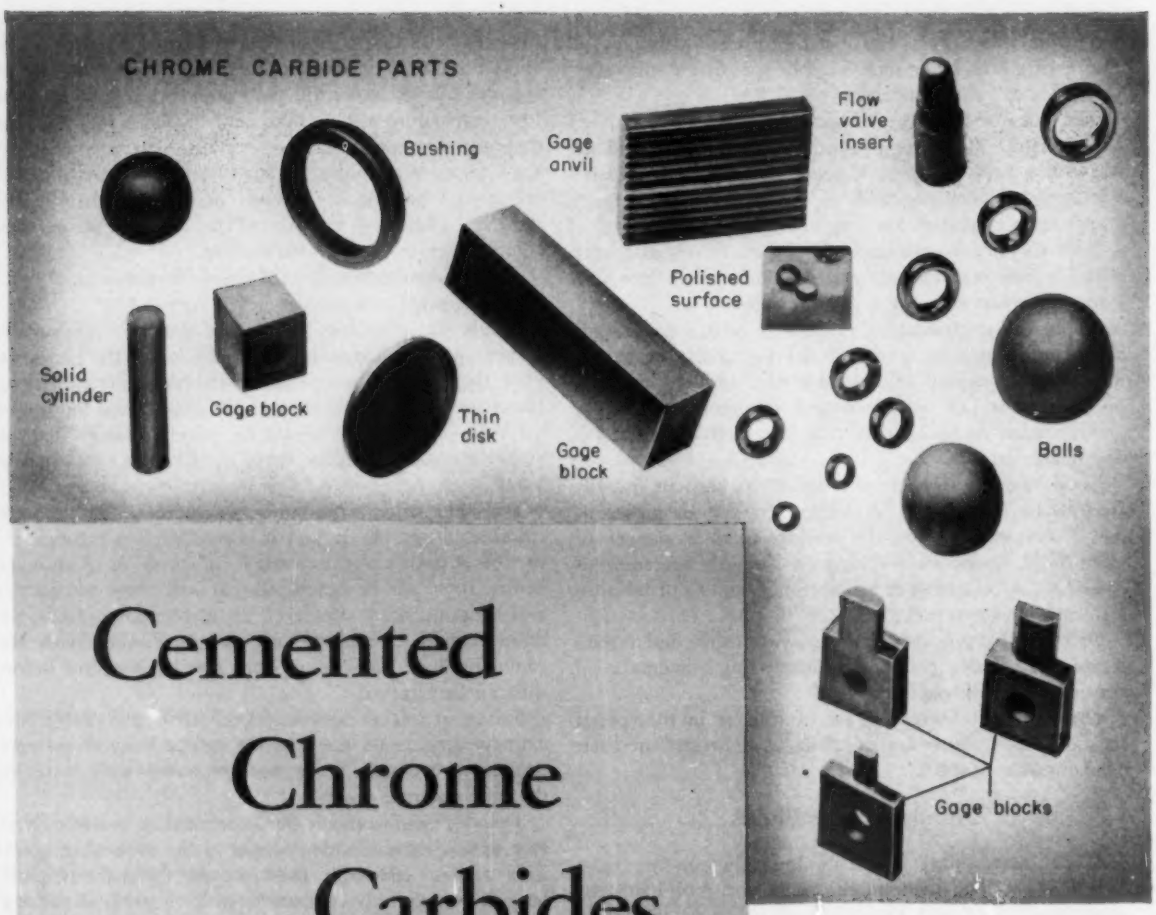
Since water is an economical, effective, and stable fire-extinguishing agent, much of the earliest research on nonflammable hydraulic fluids was conducted with water as the base material.

The first nonflammable fluid consisted of a water-glycol base with a water soluble polymer as the thickening agent. This solution effectively overcame the flammability problem. It was entirely compatible with commercial packing materials, possessed good oxidation stability and had a high viscosity index. However, the earlier fluids of this type did lack many of the necessary properties of a suitable hydraulic fluid.

At present, water-base fluids are being developed and field tested which possess all of the properties required for use in hydraulic circuits. They have good lubricating properties, have low pour points, do not cause rusting, are compatible with common packing materials and can be easily adjusted if a portion of the water is lost through evaporation. It is expected that future water-base nonflammable fluids will perform the same functions as high grade petroleum oils.

Because they are mainly synthetic compounds, these nonflammable fluids are higher priced than conventional petroleum fluids. However, the hazards that are encountered when petroleum oils under high pressure are exposed to flammable conditions make the use of fire-resistant fluids imperative despite the higher cost.

While these facts give a general background in the selection of hydraulic fluids, the experience and research facilities of the fluid manufacturer or component manufacturer should be relied upon in unique or unusual applications since special fluids can often be compounded that will ideally meet the requirements of these applications. In Table III is shown a listing of the type of data that should be supplied to the hydraulic oil manufacturer when ordering oil for a specific application.



Cemented Chrome Carbides

Application data for a recently developed cemented carbide material, the properties of which supplement those of the tungsten carbide group and of the heat-treated steels. This low cobalt or cobalt-free hard cemented carbide can be attached to steel and cast iron by brazing.

J. D. KENNEDY
Manager Product Projects
Carboloy Department, General Electric Company

IN THE SEARCH for a cemented metallic carbide having properties that would approach those of tungsten carbide, many carbides of other less strategic, less expensive, and more abundant metals have been investigated during the last ten years. Such research and development work with chromium has resulted in a new family of carbides having many desirable engineering properties.

These chrome carbides lack the cutting properties of tungsten carbide but fill the requirements of hardness, wear resistance, corrosion resistance, and chemical resistance needed in many applications.

Chrome cemented carbides are produced by powder metallurgy techniques. Basically, they are made by cementing fine hard particles of chromium carbide together in a binder matrix of nickel.

The metallic carbide is obtained by heating a mixture of the oxide of the basic metal in powder form and powdered carbon. In producing a chrome carbide part, this metallic carbide is mixed with the powder metal binder, pressed in a die or mold to form a compact, pre-sintered, machined if necessary, and finally sintered. The size, shape and weight of the parts that can be produced are limited by available press capacity, the complexity of mold or die construction required, and the difficulty associated with pre-forming or sintering the part.

With present facilities and equip-

Table I—Standard Aerated Tests With Cemented Carbides and Stainless Steel

Values given under "Results" are milligrams of weight lost per square decimeter per day as calculated from data obtained in 10 to 24 hour immersion periods.

Corrosive Agent	Typical Applications	Results				
		Grade 608 chrome carbide	Other Cemented Carbides			18-8 Stainless Steel
			WC+Co	WC+TaC+TiC+Co	WC+TaC+Co	
10% H_2SO_4	Pickling, electroplating, electrical batteries.	55	158	302	135	1650
50% H_2SO_4	Manufacture of fertiliser, chemicals, explosives.	31	100	120	81	7300
37% HCl	Tanning leather, pickling acid, manufacture of ceramics, dyes, etc.	190	600	650	160	Total Loss
35% HNO_3	Manufacture of explosives, organic chemicals, metallurgical refining processes, etc.	19	250	330	110	45
HNO_3—HCl	Used principally for corrosion tests. Also, metallurgical processing.	810	2820	4500	1550	Total Loss
NaClO .07 Cl_2, PH 9	Bleach paper, textiles. Also water purification.	100	230	1000	158	11
5% NaOH	Manufacture of textiles, rayons, etc.	0.6	22	7	12	1.0
50% NaOH	Soap manufacture, petroleum refining, rubber reclaiming	1.0	3	3	4	2.0
5% $CaCl_2$	Road dressing, fire proofing agent, manufacture of pharmaceuticals.	0.3 0.3	41 41	24 24	27 27	1.3 1.3
1.0% Citric Acid	Manufacture of pharmaceuticals, soft drinks, and flavoring extracts.	0.6	176	150	160	2.0
5.0% Lactic Acid	Manufacture of leather and textiles. Encountered in dairy industry.	1.5	200	170	255	5.1

ment, parts can be produced that have a maximum pressed face area of about 28 sq in., this area is equivalent to a maximum diameter of about 6 in.; maximum length of parts is limited to about 8 in. Large length-to-diameter or length-to-width ratios are often undesirable because of the warpage that occurs during sintering.

Undercuts and re-entrant profiles are limited by sintering hazards, and by the machining operations that can be performed on the pre-sintered compact. These operations include turning, boring and grinding. After final sintering, the hardness of the material is such that only grinding, lapping, diamond chip machining, electrolytic machining, and polishing operations are possible.

A few typical shapes that have been produced in chrome carbide are shown above. These parts represent a range of diversity in size, cross sections, and width-to-length ratios.

In compounding the composition of the chrome carbide metal powder mixture, the combinations of material proportions are infinite. For practical compositions, however, the proportion of binder ranges from 40 percent maximum to 2 percent minimum.

After field testing several compositions, the one that yielded the best promise for immediate acceptance and application in industry was put into production. This material, known as

In compounding the composition nominal chemical composition of 83 percent chromium carbide, 2 percent tungsten carbide and 15 percent nickel.

Physical and Mechanical Properties

The potential hardness of the family of cemented chrome carbides ranges approximately from 85 to 93 Rockwell A; that of Grade 608 is 88 at room temperature. Rate of abrasion, of course, depends upon many factors, but some indication of how chrome carbides stand up under abrasive conditions is given by tests conducted at The Armour Research Foundation on samples of chrome carbides and tungsten carbides.

In these tests, a sample of chrome carbide grade 608, having a Rockwell A hardness of 88, was held against a rotating rubber wheel. One face of the specimen was held against the wheel with a force of 40 lb. During the test, the wheel was continuously loaded with aluminum oxide grit. After a run of 32,000 ft, weight measurements indicated that 5.8 grams were removed from the specimen.

In simlar tests, weight losses for tungsten carbide samples varied from 0.65 to 1.9 grams. While these tests indicated the superior abrasion resistance of tungsten carbides, application

test data show that the abrasion resistance of grade 608 chrome carbide is superior to that of heat-treated steels.

TRANSVERSE RUPTURE STRENGTH. Based on tests in which $\frac{1}{4} \times \frac{1}{4}$ in. grade 608 specimens were broken across centers $1\frac{1}{2}$ in. apart, the transverse rupture strength is 100,000 psi. This value is computed from the formula

$$R = 3\ PL/2\ bd^2$$

in which

R = transverse rupture strength
P = breaking load applied midway between centers, lb
L = distance between supporting centers, in.
b = width of specimen, in.
d = depth of specimen, in.

COMPRESSIVE STRENGTH. No available data; compressive strength is assumed to be about 600,000 psi.

MAGNETIC PERMEABILITY. No definite data. Magnetometer tests indicate low magnetic permeabilty, which is attributed to a high degree of solubility between the chrome carbide and the nickel binder.

CORROSION RESISTANCE. In Table I, results are given of corrosion tests in which grade 608 chrome carbides were immersed in different chemical solutions. The superiority of grade 608 over tungsten carbides and 18-8 stainless steel is evident.

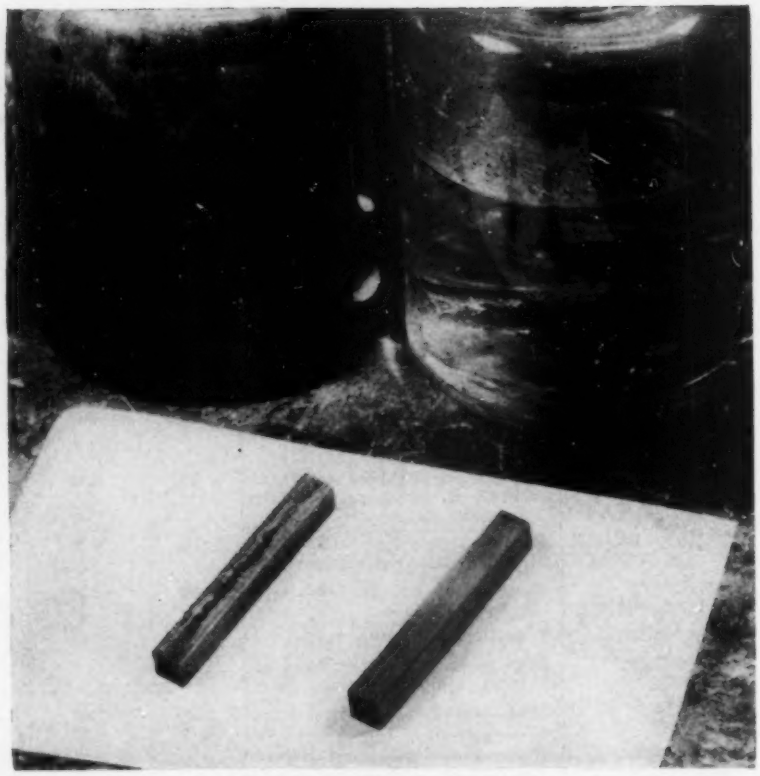
RESISTANCE TO OXIDATION. In a test to determine the resistance of grade 608 to oxidation at elevated temperature, a specimen $\frac{1}{4} \times \frac{1}{4} \times 1\frac{3}{4}$ in. with ground surfaces was heated for 24 hours in an open furnace having an air atmosphere and a temperature of 1800 F. After removal from the furnace and cooled to room temperature, the specimen was only slightly discolored. There was no scaling or appreciable change in dimensions. Tungsten carbide and 18-8 stainless steel samples were appreciably oxidized.

RESISTANCE TO STEAM EROSION. Test was conducted with two samples of chrome carbide grade 608, each having a diameter of $1\frac{1}{2}$ in. and ground to a thickness of 0.250 in. One face of each sample was placed at a distance of 0.005 in. from the face of nozzles having an orifice $\frac{1}{16}$ in. dia. The samples were then exposed to a jet of 350 psi saturated steam.

After an exposure period of 25 hours, the specimens were examined and the maximum erosion penetration was measured. The test was concluded after four such 25 hour periods. Total exposure time was 100 hours.

To average out the effects of any errors that might result from a difference in nozzle characteristics, after each 25 hour period the specimens were alternated in front of the nozzles.

Results of this test showed no measurable erosion penetration on the samples after the first three 25 hour periods. After 100 hours, the maximum penetration was 0.00024 in. in one specimen and 0.00055 in. in the other, giving an average of 0.0004 inches.



In corrosion resistance test with sulphuric acid, the resistance of grade 608 chrome carbide (right) was thirty times more than that of conventional carbides.

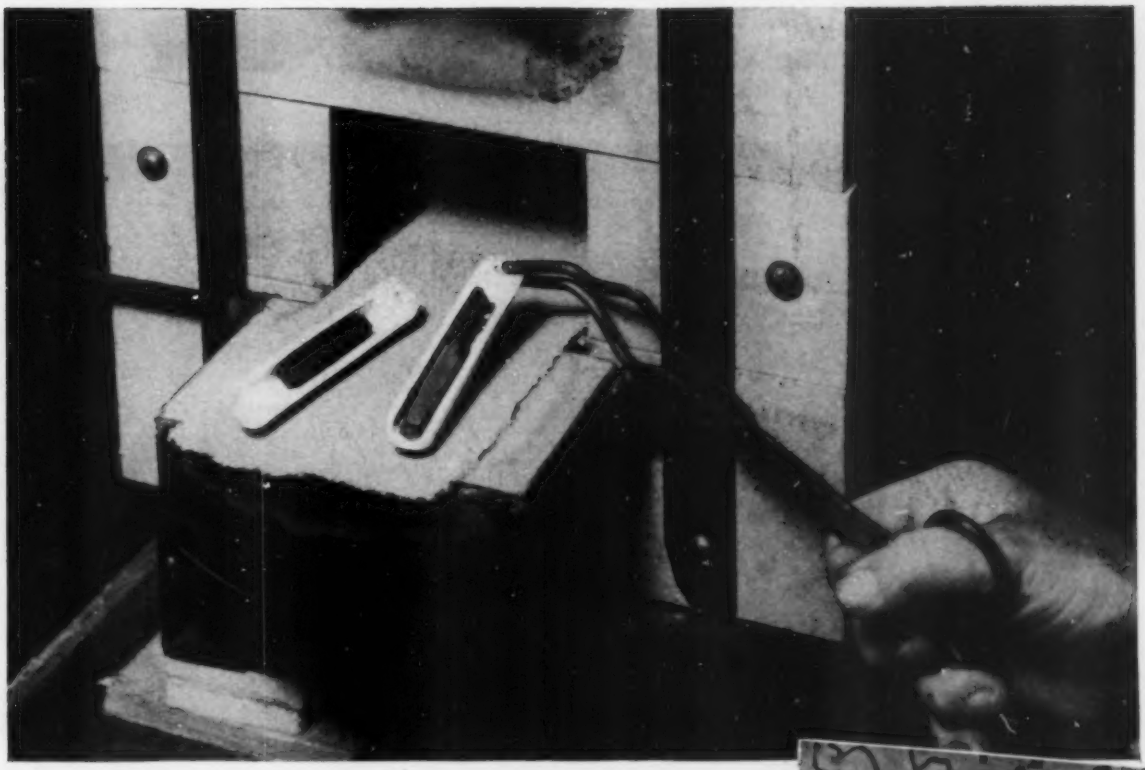
COEFFICIENTS OF THERMAL EXPANSION. In the temperature range of 68 to 248 F, the linear coefficient of thermal expansion of chrome carbide grade 608 is 4.9×10^{-6} in. per in. per deg F. This coefficient is about 80 percent that of SAE-1095 steel in similar temperature ranges.

Finishing and Attaching Techniques

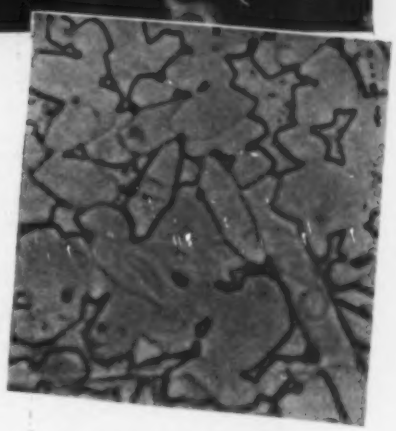
Chrome carbides can be polished to a brilliant metallic lustre. These materials can be ground, lapped, and polished with diamond grinding wheels, diamond lapping compounds, and conventional silicon carbide. Electrolytic and electro spark grinding operations give satisfactory results.

Chrome carbides can be joined by brazing with Handy and Harmon "EB" silver alloy base brazing materials to steel and cast iron. Strength of brazed steel joints at room temperature is approximately 25,000 psi.

Another technique for joining or attaching chrome carbide parts to metals is that of adhesive cementing with ethoxyline resins. These thermosetting resins are characterized by high mechanical strength and high adhesion to metallic surfaces. They contain no solvents that must be evaporated to cause hardening; a property that makes them particularly suitable for joining



Chrome carbide specimen (left) is slightly discolored after 24 hr at 1850 F; tungsten carbide specimen is heavily oxidized.



Microstructure of chrome carbide is notable for the uniformity and interlocking character of the grain structure.

nonporous materials like metal parts.

The bond strength is much lower than that of brazed joints. The strength of cement bonds ranges from 6,000 to 8,000 psi in shear at room temperatures. Such cemented joints can be employed as a means of attachment when high strengths are not required and when the application is exposed to room or slightly elevated temperatures.

The surfaces to be joined by cementing, both carbide and steel, should be grit-blasted and rinsed clean with trichlorethylene or similar solvent. Ground or smooth surfaces do not bond well but as-sintered surfaces produce strong bonds. This cementing technique, however, is advantageous in attaching carbides to thin sections or to materials that would be damaged by brazing temperatures.

Suggested Applications

Precision Gage Blocks, Gage Anvils, Ring Gages, Plug Gages. Coefficient of thermal expansion of grade 608 is closer to that of steel than is that of tungsten carbide. In these applications, the wear resistant and corrosion resistant properties of the chrome carbides are advantageous.

Inserts for Heading Hammer. In cold heading silver rivets, tungsten carbide dies picked up silver with a resulting breakdown of the carbide. Chrome carbide exhibited an anti-weld characteristic plus good impact and compressive strength. The maximum life of tungsten carbide inserts is about 80,000 rivets, that of grade 608 inserts is about two million rivets.

Dies for Hot Extrusion of Metals. In preliminary tests, brass and silver base alloys have been extruded to size and shape through cemented chrome carbide dies. In these applications, the heat and wear resistance qualities of this new material are advantageous.

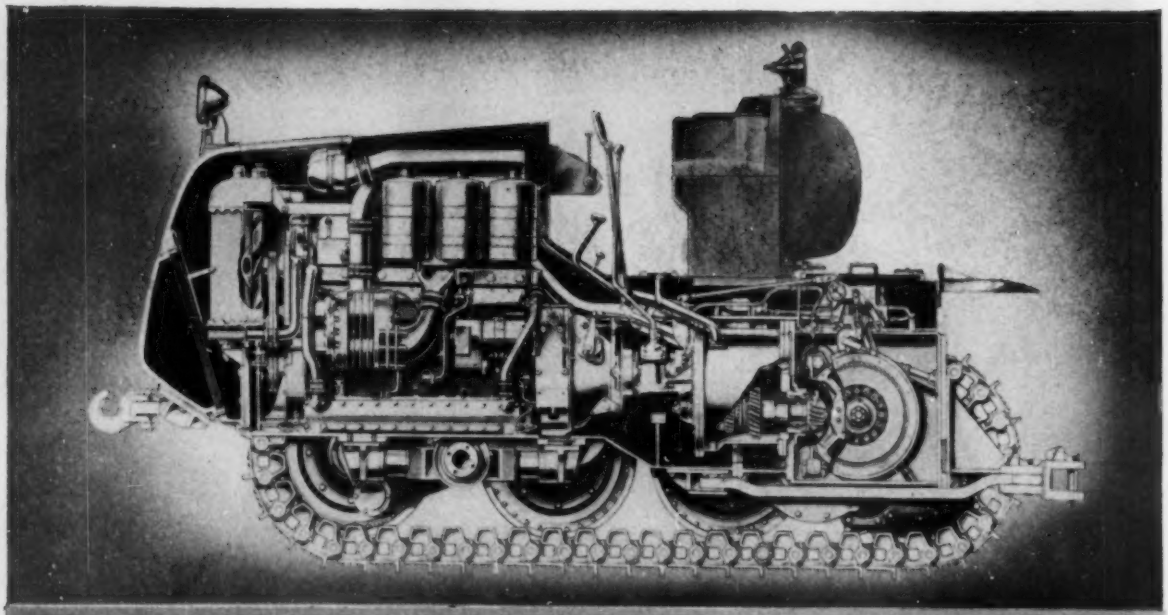
Balls and Seats for Oil Pump Valves. Chrome carbides are used to combat corrosion and abrasion.

Instrument Bearings, Bearing Plates, and Fulcrums. In such applications where hardness and nonmagnetic properties are important, the chrome carbides may offer many advantages.

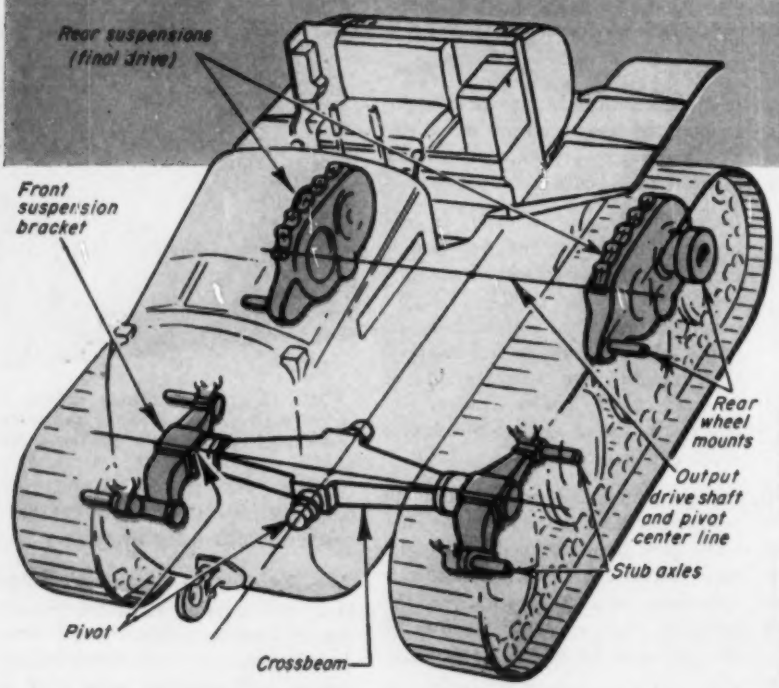
Core Pins for Baked Ceramic Parts. Heat and abrasion resistance properties of chrome carbides make them desirable for core pins when baking ceramic and porcelain parts such as spark plug bodies.

Components of Food Processing Machinery. Corrosion resistance of chrome carbides to lactic or amino acids are needed in many components.

DESIGN FEATURES



FABRICATED from ¼ in. welded steel plate, the tractor is constructed in two sections consisting of front suspension and engine; back has the transmission and final drive.



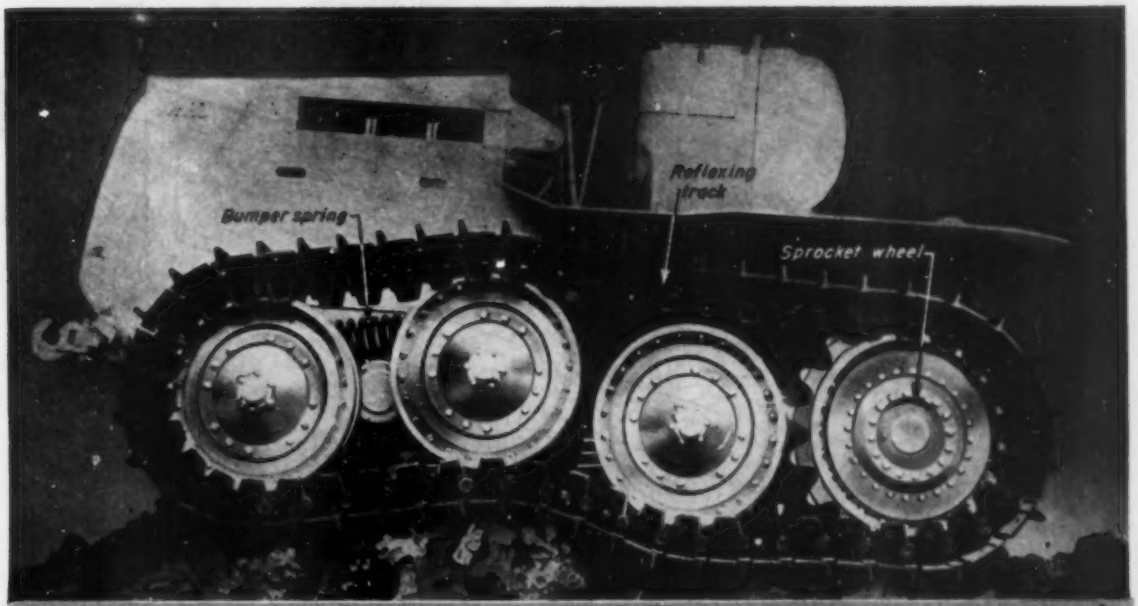
TRACTOR WEIGHT is evenly distributed by the front axle beam that pivots laterally in a pair of trunnions mounted under the front section of the hull and by two rear units pivoting radially about the output drive shaft from the reduction gear. The front wheels are mounted on stub axles at either end of a balance beam. The rear wheels are mounted on the rear suspension assemblies.

Three-Point

A fully articulated suspension consisting of a front axle beam that is free to pivot laterally and two rear assemblies that are free to pivot radially forms the basis for a new tractor design—a design based on the premise that demands for greater drawbar payloads should be met by increasing the operational speeds rather than by building larger tractors. As a result, Vickers-Armstrongs developed their VR-180, a 16 ton tractor capable of pulling 29,500 lb, at full engine torque.

The three-point suspension principle enables the basic speed of operation to be raised by evenly distribut-

IN NEW PRODUCTS



REAR SPROCKET WHEELS transmit the drive to the reflexing track, the other wheels acting as weight carriers and top rollers. Tension in the track, caused by obstructions, is compensated for by large coil bumper springs mounted on the tractor hull and acting on the front wheels. The spring pulls the wheels away from the track until the obstruction is passed. Besides acting to spread the tractor weight evenly, the large wheels reduce mud packing and have the advantage of revolving comparatively slowly.

Suspension Spreads Tractor Weight

ing the tractor weight between the central pivot of the front suspension and the two rear assemblies. This feature allows full use of the available power under all road surface conditions.

Four large diameter track wheels on each side spread the body weight over the track and on the ground. To take full advantage of the articulated suspension and its balanced load distribution, use is made of a flexible track to form a metal road over ground surface variations. With the entire track length always on the ground, gripping power is increased over that possible with conventional rigid track frame construction.

A 180 hp Rolls-Royce 6-cylinder semi-diesel engine powers the new tractor, the power being transmitted through an all helical gear, constant-mesh gear box that has six forward and three reverse ratios. Since all gears are in constant engagement, speed and direction changes can be made while the tractor is moving.

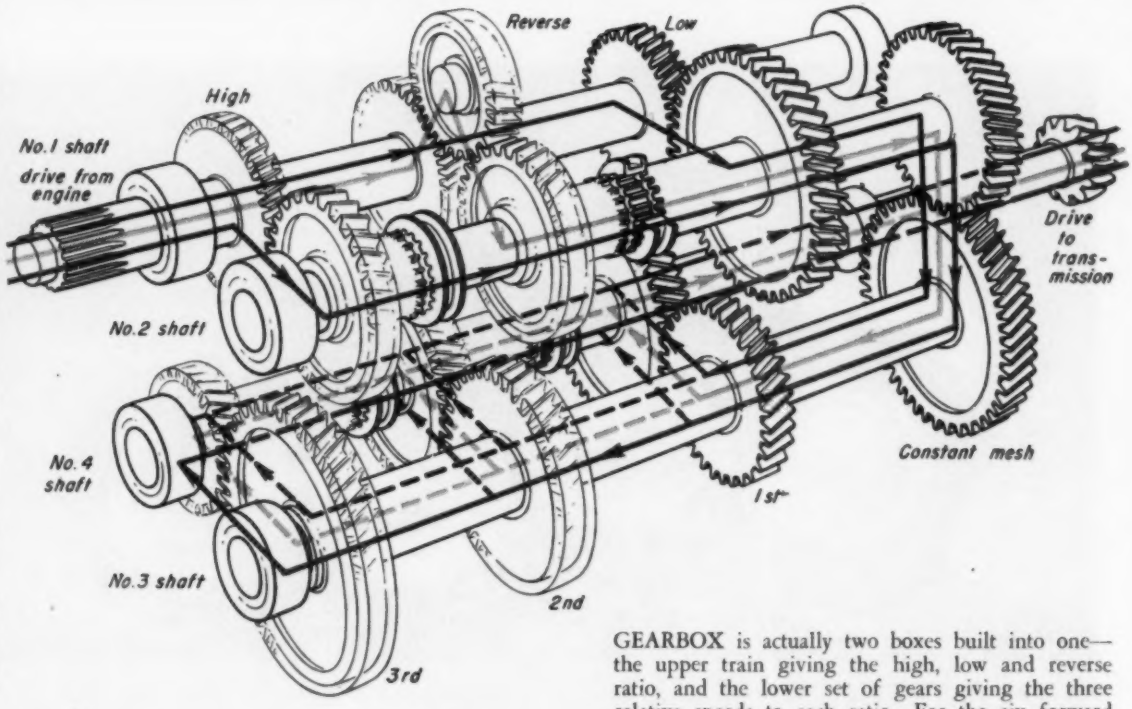
Steering and braking is done by means of two spring-loaded fabric disk clutches and 3-shoe external contracting brakes located on either side of the drive spiral bevel gear. The clutches are initially actuated by steering levers through a hydraulic servo system and the brakes by direct mechanical linkage. This design insures control sensitivity and reduces brake wear.

Other design features include a completely encased engine compartment for pressurized cooling and an externally located heat exchanger for maintaining the oil temperature at the proper level.

For starting, a 24-volt installation is used, consisting of four 185 amp. hour non-spilling batteries. To offset possible starting failure, provision is made for inter-tractor or slave battery assistance.

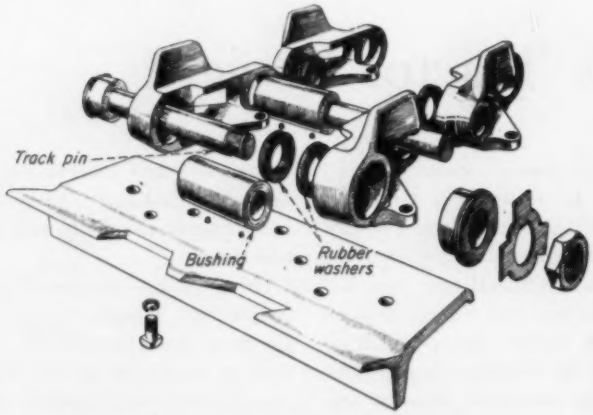
(continued on next page)

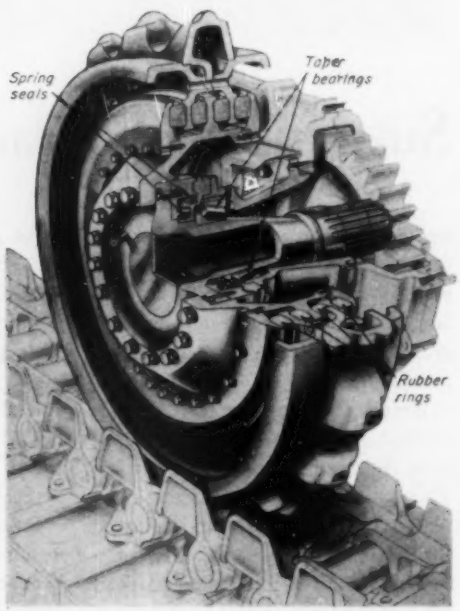
Three-Point Suspension (continued)



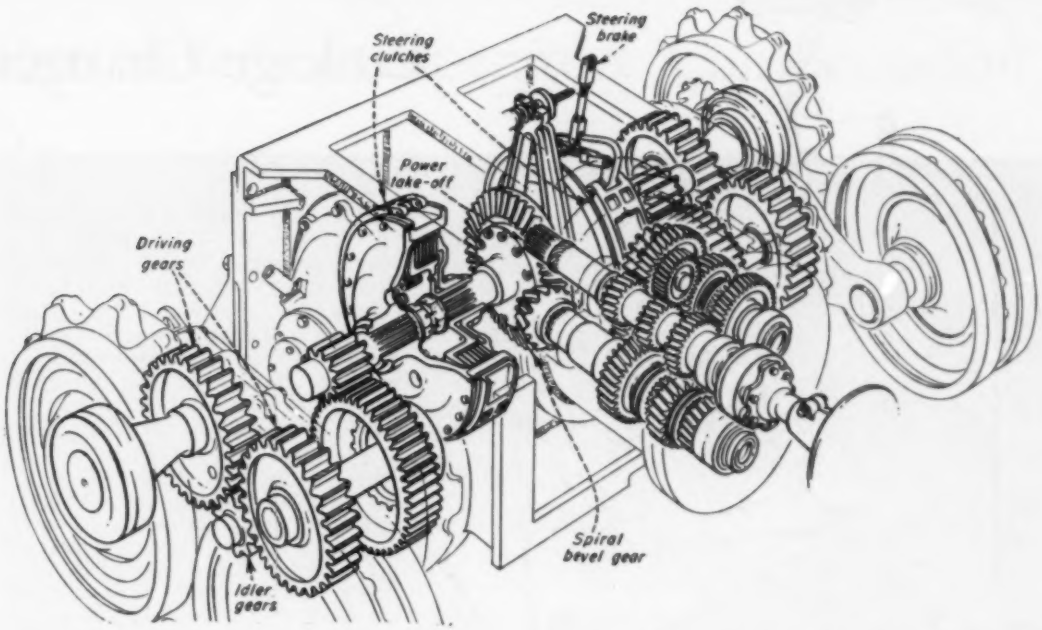
GEARBOX is actually two boxes built into one—the upper train giving the high, low and reverse ratio, and the lower set of gears giving the three relative speeds to each ratio. For the six forward speeds, the actual change from bottom to top can be done in three movements. First low gear is 2.18 mph and top speed is 9.73 miles per hour.

SINCE CONTINUED FLEXING would quickly wear out a conventional dry-pin track, new track construction has pins running in oil and are sealed by oil-proof rubber washers. Once sealed during assembly, the track pins require no additional lubrication until overhaul.



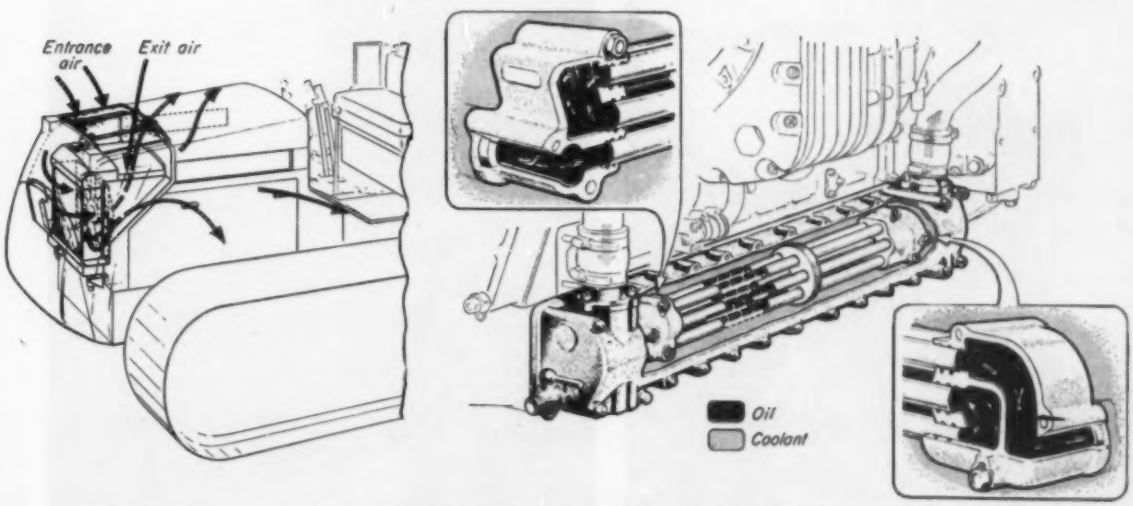


SPROCKET WHEELS are designed with four rubber rings to both dampen out high frequency vibrations that could be transmitted to the tractor body and to cushion the "take-up" on the drive shaft. Wheel hubs are mounted on large diameter taper roller bearings. Twin spring loaded seals act to keep the lubricating oil in and the water out.



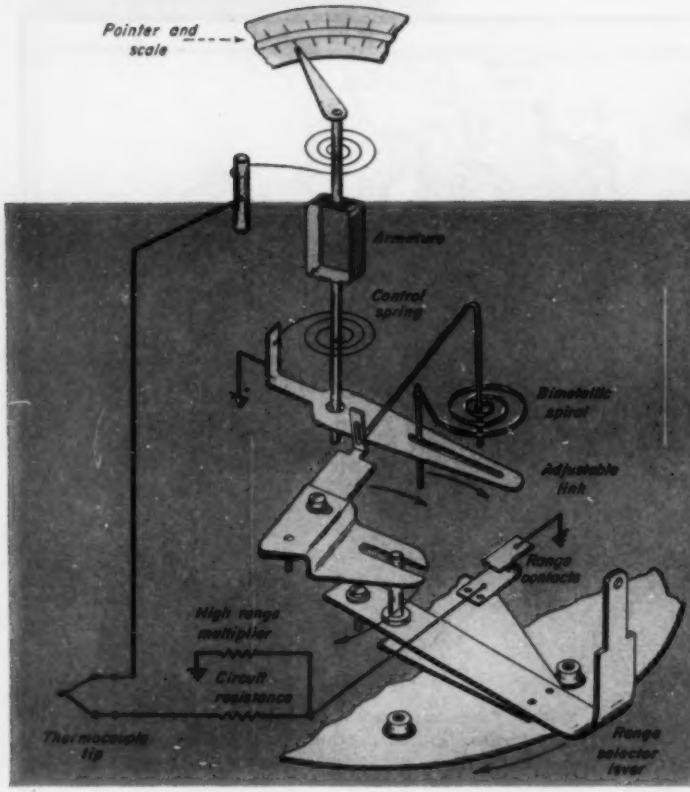
POWER from the engine is transmitted to a large spiral bevel gear that drives the output shafts to the sprocket wheels. Final drive to the sprockets is through two gears meshing with an idler gear. This arrangement maintains a constant balance between the torque on the drive and that exerted by the track on the sprocket. The steering clutches, one on either side of the spiral bevel gear, have eight toothed fabric disks normally held in engagement by coil springs. Either steering brake can be operated independently by the proper steering lever, but the foot brake pedal gives overriding control.

First movement of a steering lever allows hydraulic fluid to move the piston actuating the steering clutch. Further movement applies the steering brake by direct mechanical connection.

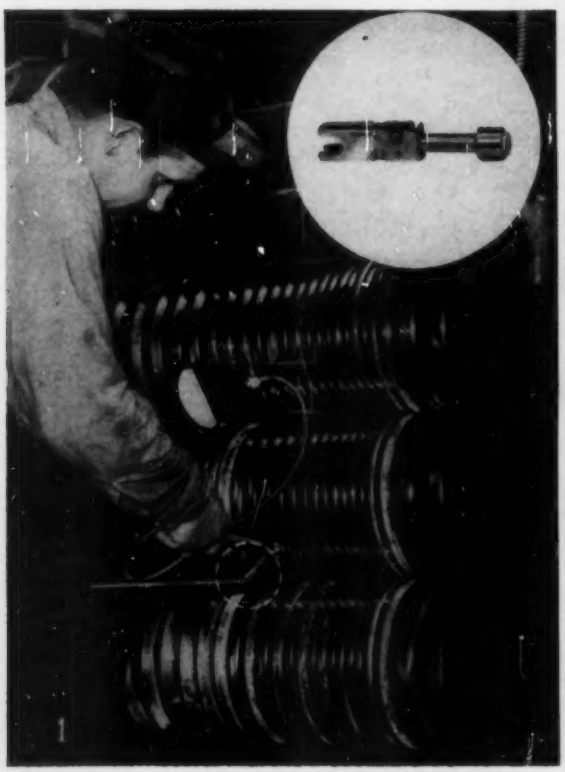


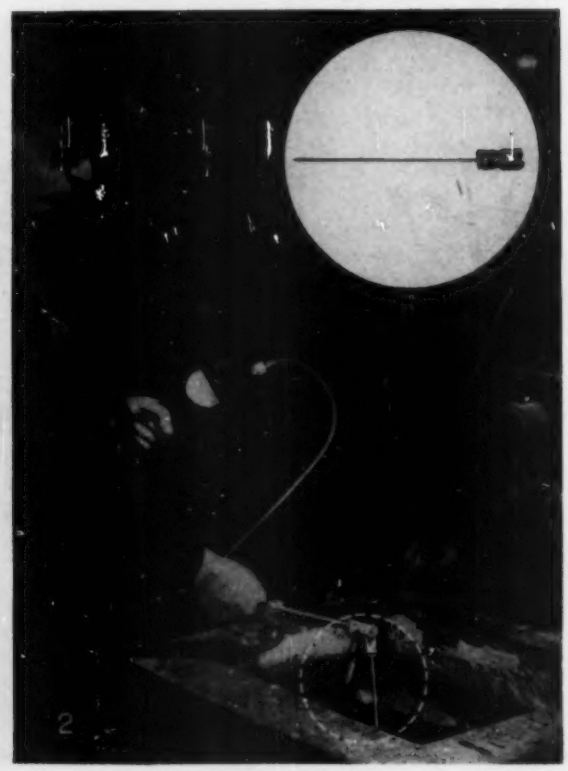
AIR enters the top of the engine housing and is drawn through the radiator by a tunnel enclosed fan. Engine air is freed from dust by swirl pre-cleaners and large capacity oil-bath cleaners. A heat exchanger built into the engine at the left side of the sump helps bring the oil quickly to working temperature from a cold start. This construction eliminates external connections.

Linkage Changes



WITH THE SELECTOR lever set for the low temperature range, as shown, ambient temperature changes cause rotation of the bimetallic spiral moving the adjustable link. This movement changes the position of the lower control spring compensating the instrument pointer for the ambient temperature. Movement of the selector lever to the left, for the high range, rotates the bimetallic spiral to form a longer lever arm for the adjustable link. For the same ambient temperature change, the control spring is rotated less than before, adjusting the temperature compensation to the crowded scale of the high range. Movement of the lever also changes the electrical circuit to receive a different output from the thermocouple.





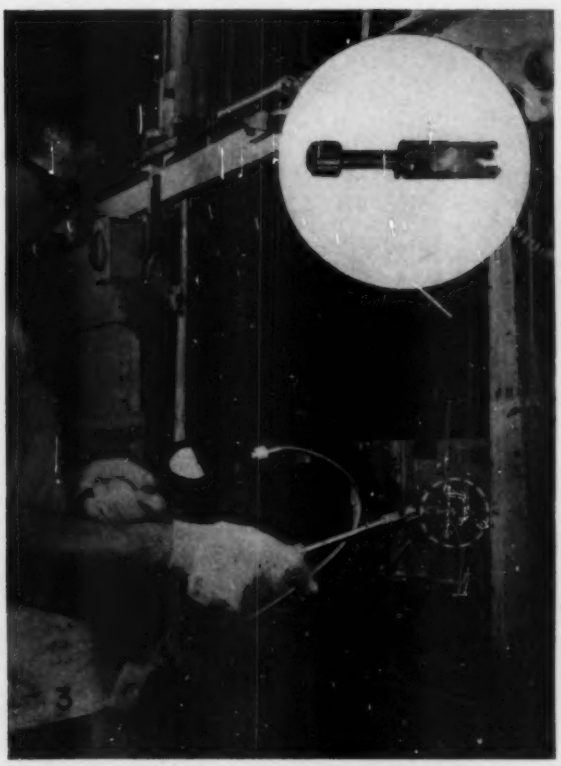
Pyrometer's Temperature Compensation

A new double-range hand pyrometer featuring built-in ambient temperature compensation for both the high and low scale ranges by changing the length of an adjustable link has been developed by the Meter and Instrument Department of the General Electric Company.

Compensation for the wide variations in ambient temperatures which surround the test equipment is obtained by a bimetallic spiral which regulates the angular position of the instrument's lower control spring through a mechanical linkage system. Adjustment of this compensation to either the high or low temperature range is accomplished automatically by operating the range selector lever. Movement of the lever changes the position of the bimetallic spiral, thus varying the effective length of the mechanical link, and giving the proper compensation for whichever range is to be used.

This automatic adjustment is in contrast to the methods generally used for compensating conventional single and double-range instruments. In single range units, a bimetallic spring is usually attached to the end of a control spring; for double-range pyrometers, the scale is zero-set for room temperature before each reading.

According to S. M. Billings of General Electric's Meter and Instrument Dept., the design of interchangeable thermocouple tips and a flexible extension arm makes the new pyrometer adaptable to many applications. A surface tip is used for determining the temperature or solids; an immersion tip, for liquids; and a contact tip, for metals.



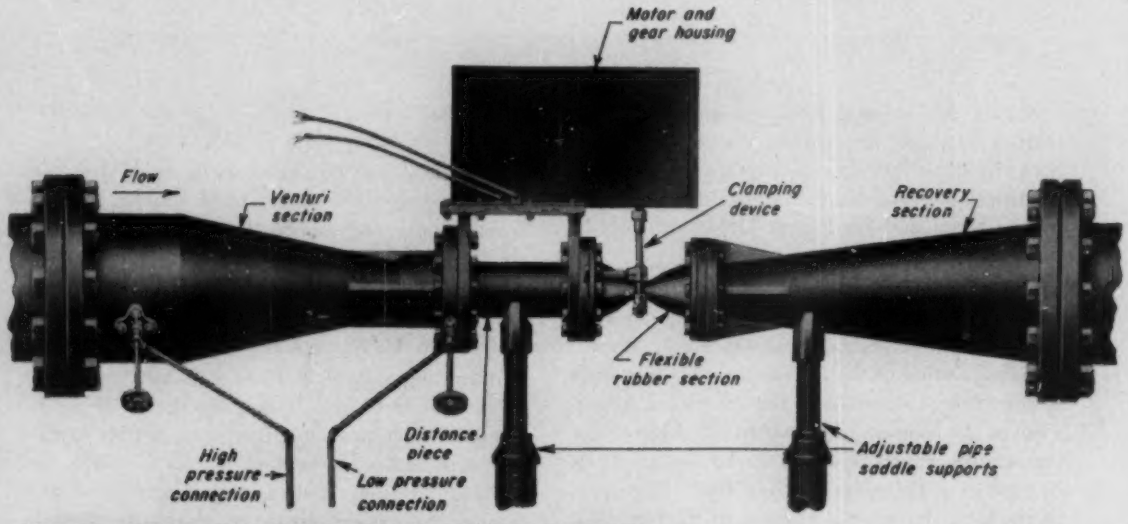
1. A surface type thermocouple tip is used to determine the temperature of hot-rolled metal bar stock. The high range of the pyrometer is employed since the metal's finishing temperature may be between 1000 and 1500 F.

2. An immersion-type tip facilitates the measurement of the temperature of a molten salt bath. Since these baths are maintained at temperatures from 400 to 1500 F, both the high and low range of the pyrometer are used.

3. Measuring the temperature of butyl rubber molds to insure proper curing by use of a hand pyrometer equipped with a surface type thermocouple tip. Since the plastic butyl rubber injected into steel molds is maintained at curing temperatures from 300 to 500 F, the pyrometer's low scale is used.

4. A contact type thermocouple tip is used to measure the temperature of commutator segments in a locomotive motor. The temperature of the segments is approximately 300 F requiring selection of the pyrometer's low range.

THE CONTROLLER consists of six principal elements: venturi, distance piece, flexible rubber valve, recovery section, motor and gear housing, and the clamping device. Flow through the controller sets up a differential pressure across the venturi tube which is used to establish the control setting.

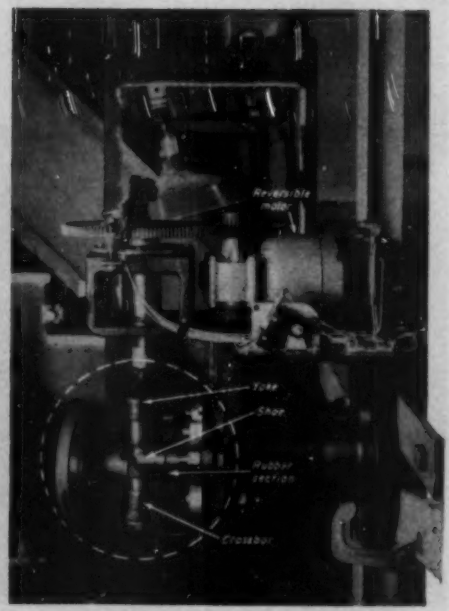


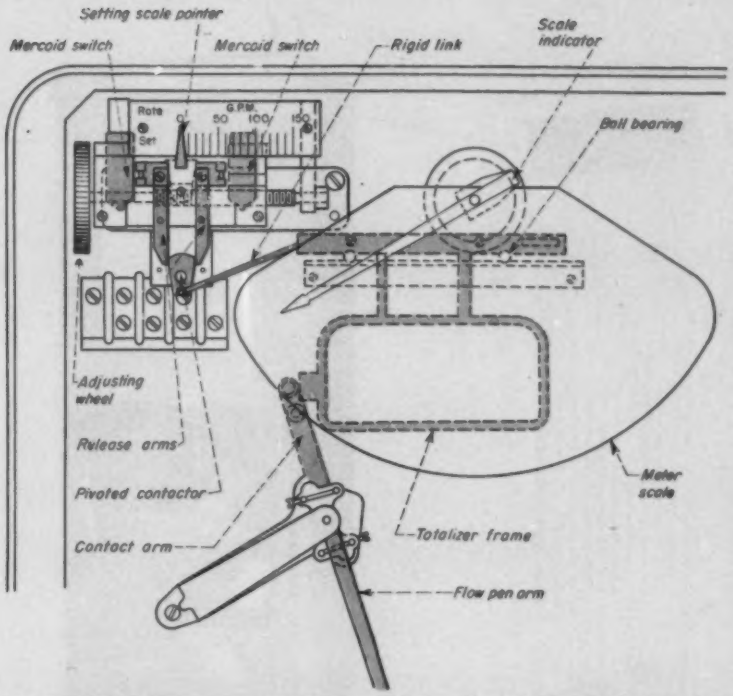
Clamping

To obtain a controller that could regulate the flow of viscous fluids but would have no moving parts in direct contact with such fluids, Simplex Valve and Meter Co., Philadelphia, Pa. developed a controller utilizing a mechanical clamp that regulates the flow by decreasing the cross-sectional area of a length of rubber hosing. There are no valves to stick or be made inoperative by contact with extremely viscous fluids.

The controlling element for the operating mechanism is a special indicating meter that contains a leaf spring contact arrangement for energizing the clamp-operating motor. Movement of the spring actuates the motor to restrict or release the rubber section, depending upon the rate of flow.

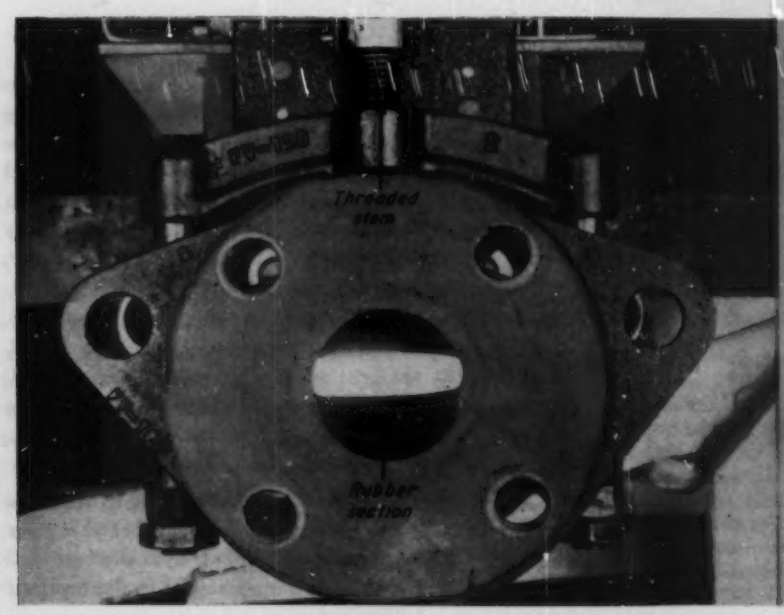
Flow through the controller sets up a differential pressure across a venturi section. This action moves a pointer in the meter to correspond with the rate of flow through the unit. The leaf spring, pre-set for a desired flow rate, moves up with the pointer. Should the flow exceed the meter setting, the motor circuit is energized and the clamping device is driven down on the flexible section. When the flow drops, the leaf spring moves down with the pointer until the motor reversing circuit is energized releasing the pressure and allowing greater flow.



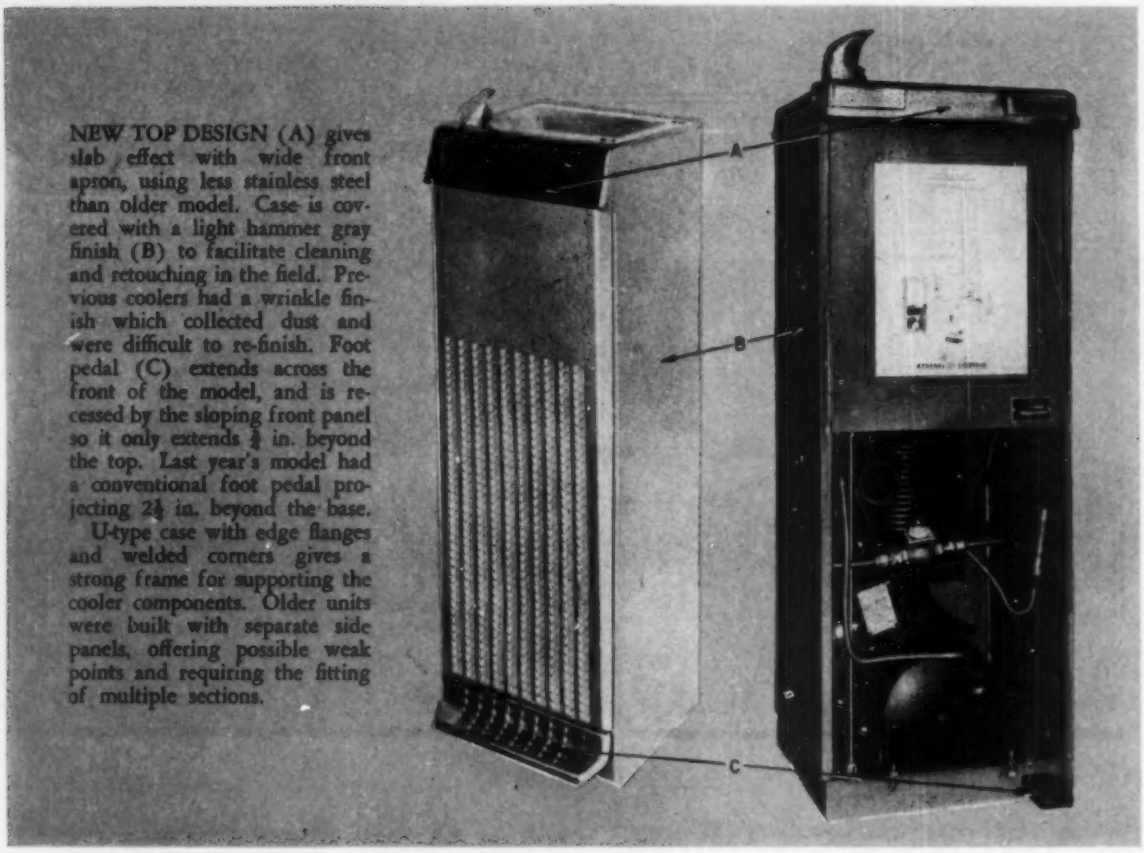


HOW THE METER control works. Positioning the setting scale pointer determines the maximum flow rate of the controller. When the flow exceeds this rate, the increased pressure differential created in the venturi is translated to a clockwise rotation of the flow pen arm. A contact arm on the other end of this member forces the totalizer frame to the right, pulling with it a hinged rigid link. Movement of the link rotates a pivoted contactor forcing a release arm away from a mercoid switch and causing the switch to return to its normally closed position. Closing the circuit energizes the reversible motor which drives the threaded stem to clamp the flexible section and restrict the flow back to its pre-set rate.

Flexible Section Controls Flow



DEPENDING upon the pressure drop across the venturi, a reversible motor, driving a gear reduction unit, positions a threaded screw either to reduce the cross sectional area of the rubber section or to release the clamping pressure. The reduction is done by squeezing the flexible valve from both the top and bottom at the same time. The revolving stem moves downward through the threaded yoke until the shoe compresses the rubber section. Downward motion is temporarily stopped and the yoke moves upward carrying the cross bar with it.



NEW TOP DESIGN (A) gives slab effect with wide front apron, using less stainless steel than older model. Case is covered with a light hammer gray finish (B) to facilitate cleaning and retouching in the field. Previous coolers had a wrinkle finish which collected dust and were difficult to re-finish. Foot pedal (C) extends across the front of the model, and is recessed by the sloping front panel so it only extends ¾ in. beyond the top. Last year's model had a conventional foot pedal projecting 2½ in. beyond the base.

U-type case with edge flanges and welded corners gives a strong frame for supporting the cooler components. Older units were built with separate side panels, offering possible weak points and requiring the fitting of multiple sections.

Small Changes Add Up to

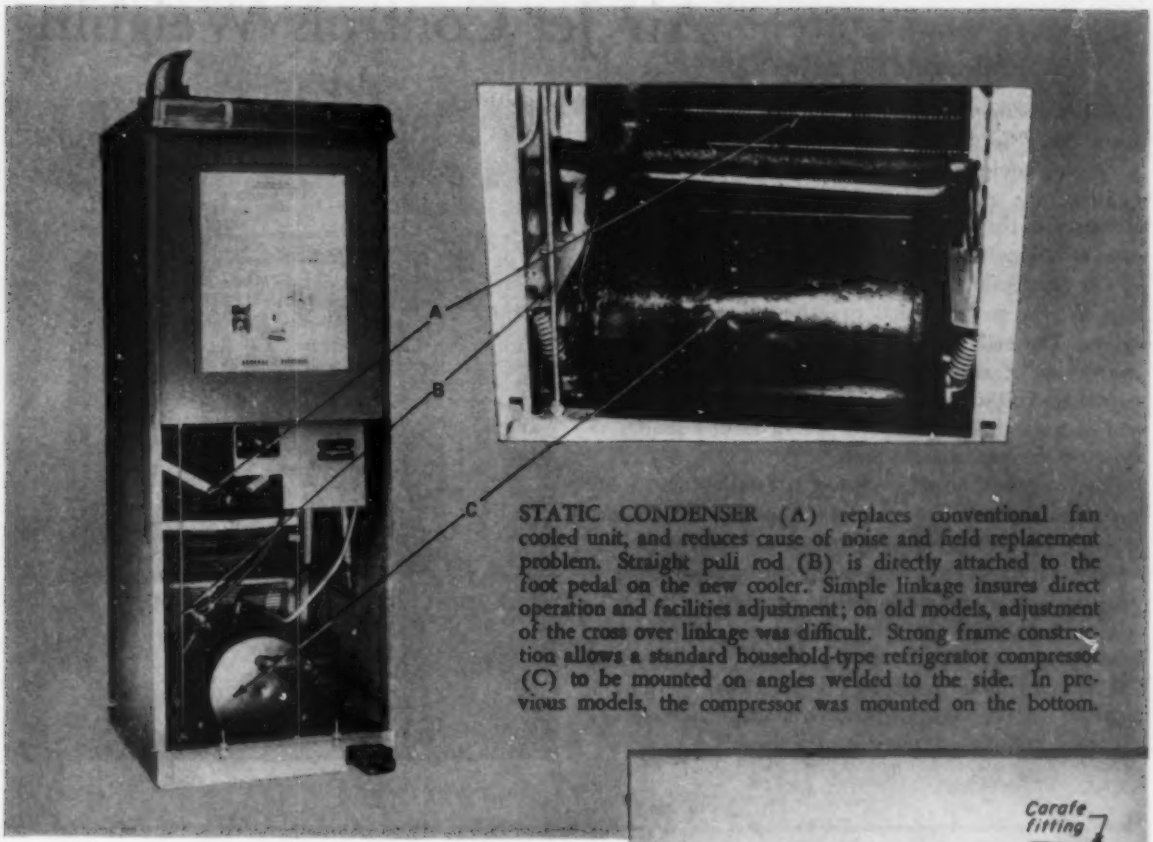
ELECTRO POLISHED FINISH instead of a tampico brushed finish cuts polishing costs. Integral nameplate insures positive identification and saves expense of separately attached nameplate. Edges of the top fit snugly into terraces on the top of the case, and are turned in and concealed. Bubbler nozzle and guard are separate pieces. Older units had both as a single component, resulting in sweating of the guard and making cleaning difficult. Selection of splash angle enabled the top to be designed from a "wash basin" effect, improving appearance and lowering die cost.

A number of small alterations to meet customer preference requirements and a desire to reduce manufacturing costs have been translated into General Electric's new water cooler, a combination of "eye-catching" appeal and simplified construction resulting in a 15 per cent slash in production costs over the old model. This allowed many improvements to be added without increasing the cost, or eliminating any of the features of older models.

Appeal changes. **Redesign of the stainless steel top conveys the impression that more metal has been added, but over 40 per cent savings in weight was realized.**

Electro polishing the top gave a more resistant surface to finger marks. Proper splash angle permitted a reduction in basin depth, decreasing die costs.

A new front panel was designed to taper in from the top to the bottom to give a streamlined effect and to offer a visual safeguard against stumbling over the extended front foot pedal. Louvers were stamped in the top part



STATIC CONDENSER (A) replaces conventional fan cooled unit, and reduces cause of noise and field replacement problem. Straight pull rod (B) is directly attached to the foot pedal on the new cooler. Simple linkage insures direct operation and facilities adjustment; on old models, adjustment of the cross over linkage was difficult. Strong frame construction allows a standard household-type refrigerator compressor (C) to be mounted on angles welded to the side. In previous models, the compressor was mounted on the bottom.

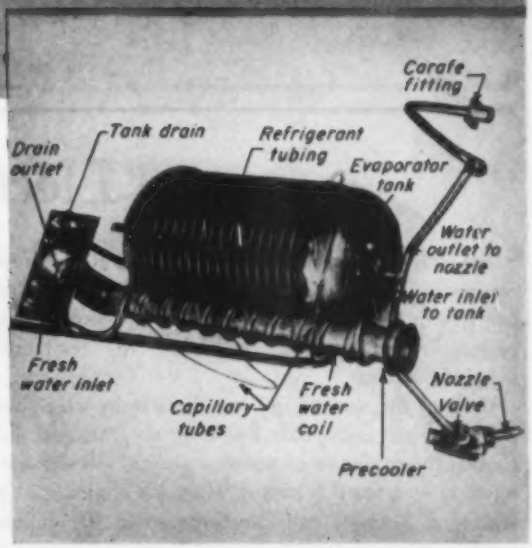
New Water Cooler

of the panel to allow cooling air to the new static condenser.

Construction Changes. The case is constructed of a one piece side-bottom-side section to give desired rigidity, and to permit spot welding of supports on the sides for mounting necessary components.

Refrigeration improvements. GE's standard household refrigerator compressor was adopted, discontinuing the use of specially built and variable capacity units. On the smaller coolers, a static condenser replaces the former fan cooled unit. Die cost was reduced by constructing the evaporator tank out of two concave end caps and a tube section. Previously, the tank was fabricated from two deep drawn pieces.

Servicing. Components are grouped to permit quick detachment without disturbing other parts, and the refrigerant system is re-grouped for easy removal and servicing as a unit.



A COMMON EVAPORATOR size simplified tooling. Higher capacity was achieved by adding more tubing and internal fins on the water side. New precooler is directly connected to the back of the case, and has a full diameter along its entire length to prevent plugging. Previous pre-cooler tubes had an expensive cast fitting at their top and were restricted at the outlet. A three way fitting, securely attached to the back panel, supports all the plumbing, and is set so that the connections are in the same location as on older models. Refrigerant flow is controlled by a capillary tube which assures dependable operation without any valve malfunctioning.

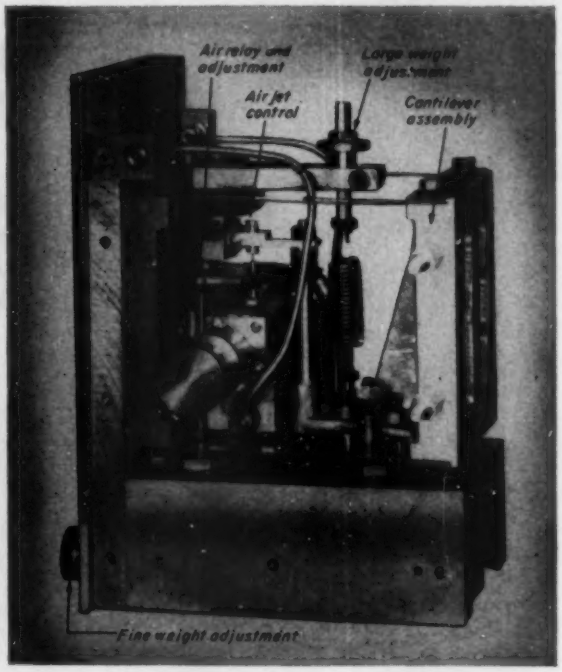
Air Jet Controls Weighing

A pneumatic weighing head, designed by the Pneumatic Scale Corp., Ltd., for attachment to high speed packaging equipment makes use of a precise air gap to automatically measure a desired weight of material. Accuracy of the net weigher, which is uneffected by volume variations, is well within ± ½ oz.

The principle of operation is the change in an air gap to increase the back pressure to actuate an air relay. The back pressure build-up in the relay causes the release of air pressure behind an air cylinder connected to a filling hopper. Release in pressure at one end of the cylinder permits a spring loaded shutter to close off further material flow.

The weighing head consists of a cantilever assembly supported on four stiff parallel leaf springs. One ounce deflects the springs about 0.002 in. To control the net weight within ½ oz, the resulting spring movement is actually only a few millionths of an inch.

Only 0.009 in dia, the air jet is directed against an air bleed control block. A minute change in the level of the floating beam assembly is sufficient to cause a build-up in the back pressure to actuate the sensitive air relay, and control the weighing operation.



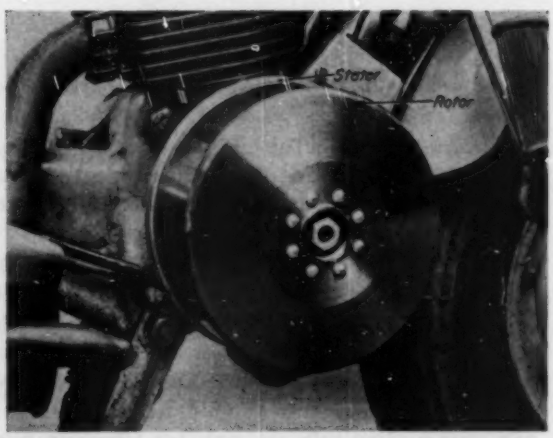
Electrical Motorcycle Starter

An Italian manufacturer of electrical automotive equipment, The Marelli Company, has designed a starting system for motorcycle engines that incorporates an unusual motor-generator to replace the conventional magneto system.

Basis of the new design is a dynamotor which fits at the end of the crankshaft, requiring no gearing or joints to start the engine or to generate power. The dynamotor operates as a starting motor when the engine is started and as a flywheel and generator when the engine is running.

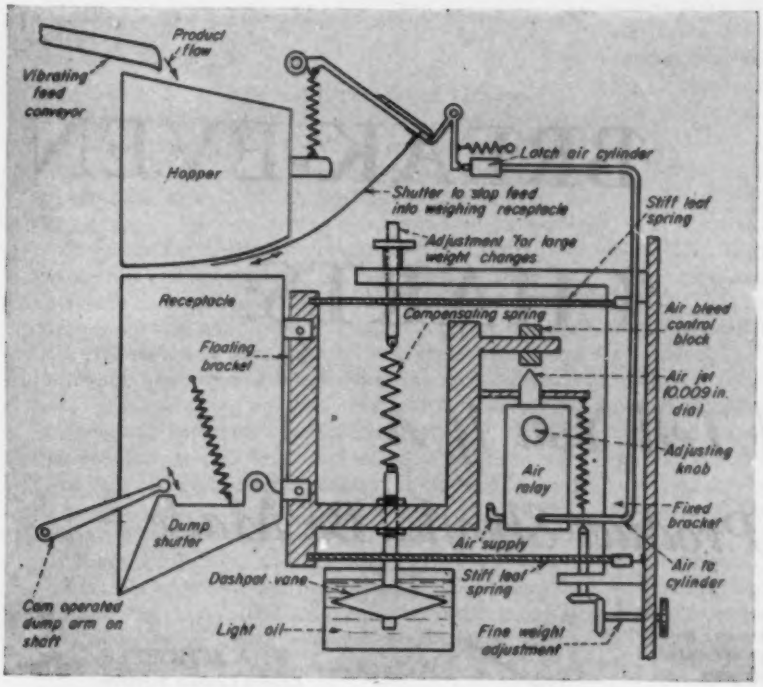
Tests have shown that the new device insures at least 100 starts before the battery needs recharging from the dynamotor. In city traffic, more than 5 starts per 3000 ft can be made without affecting the battery's change.

The dynamotor occupies slightly more space than a flywheel-magneto, but it is designed to fit engines of any piston displacement, The complete system consists of the dynamotor, starter button, ignition breaker, ignition coil, horn and battery. The voltage regulator is mounted together with the coil in a special housing.



LOCATED AT ONE END of the engine crankshaft, the dynamotor occupies the same amount of space as normally used by a conventional flywheel-magneto. The outer part of the generator is the rotor which consists of a bell supporting the rotor laminations and windings. The inner part of the unit is the stator which is of unusual design by using both series and shunt currents for excitation.

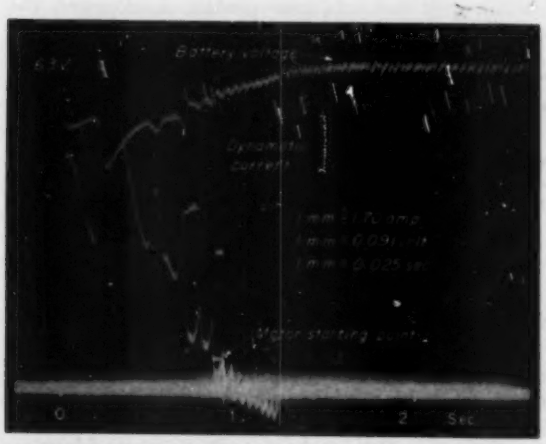
Through Unique Spring Assembly



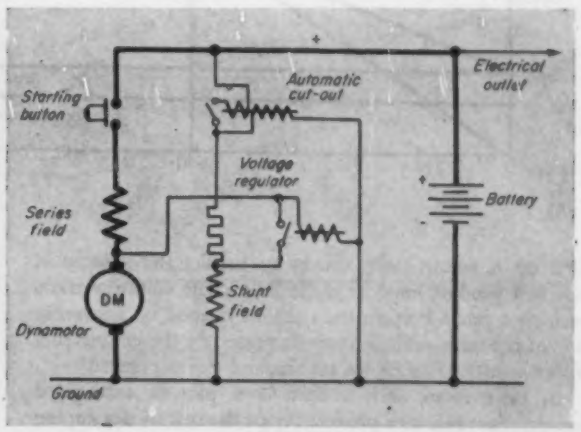
WEIGHING HEAD can be equipped for either single or dual stream weighing, in single or multiple heads for high production work. Weight sensitivity can be adjusted while the unit is operating by use of the weight control knobs. Both the sensitive air relay and the floating beam assembly are mounted in a dust-proof case to eliminate the need for adjustment.

OPERATION of the air jet control. Material fed into a hopper is allowed to flow into a filling bin. When the correct net weight is obtained in the bin, the beam assembly moves down and shortens the air gap. This movement causes a back pressure to be built-up in the air relay, actuating a valve to release the air pressure behind a latch air cylinder. Release of the pressure permits a spring loaded shutter to move under the feed hopper cutting off the material flow.

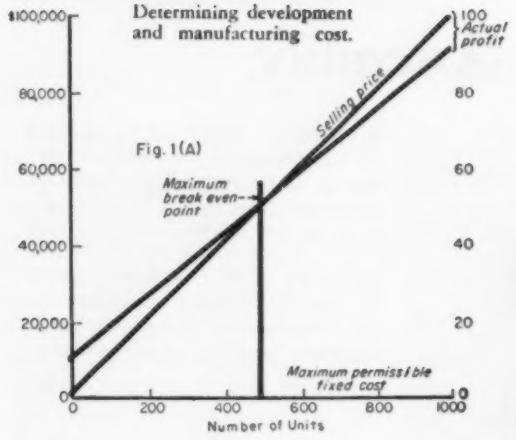
Acts As Motor and Generator



APPROXIMATELY ONE SECOND is required from the time the ignition is turned on until the dynamotor begins to operate as a generator. Tests indicate that it takes only one minute for the dynamotor to recharge the battery with the power consumed in starting. Reliability of the system eliminates the need to use a starter pedal, even as an auxiliary device.



FOR STARTING, both the series and shunt field are energized to get a strong exciting current and a high torque. When the starting button is released, the series field is de-energized and the dynamotor operates as a shunt-wound generator to charge the battery. The stator is excited partially by the series current and the rest by current from the shunt field.

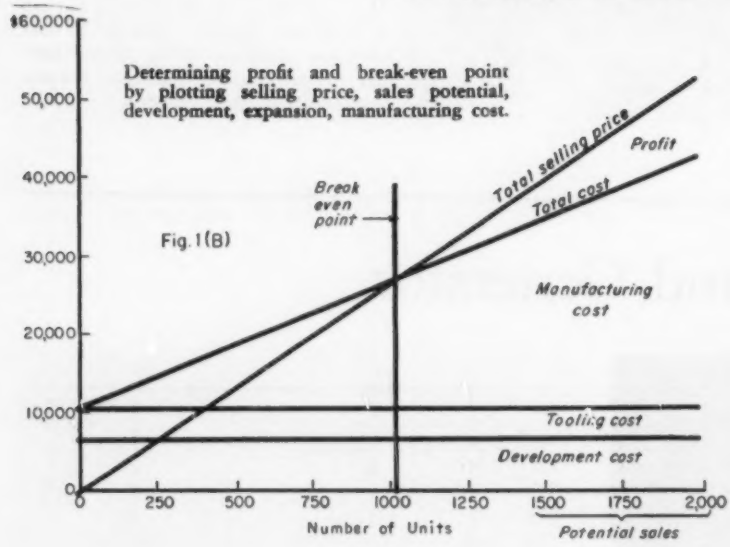


Determining development and manufacturing cost.

Fig. 1(A)

BREAK-EVEN CHARTS:

They'll Tell You If A Product Should Be Made



Determining profit and break-even point by plotting selling price, sales potential, development, expansion, manufacturing cost.

Fig. 1(B)

W. A SCHUETTE
Office & Contract Supervisor
Allis-Chalmers Manufacturing Co.

USE OF A BREAK-EVEN CHART to predict the volume in which a product must be made before the company starts making a profit is often the simplest method of answering one of the most difficult questions faced by the engineering department: "Should we recommend development?"

In basic form, such a chart is a plot of anticipated income from sale of a product versus the cost of developing and manufacturing it. Readily determined is the unknown factor—the volume necessary before all indirect charges are paid for, direct costs are covered, and a profit is made.

Break-even charts can be used also in other ways: To compare virtues of one design with those of another; to determine whether unit costs will be too high to insure sales; or even to aid in the selection of production equipment, determine whether plant mechanization is practical, or decide whether manufacturing shifts should be expanded.

In new product development, the break-even chart can reflect the economic survival of a project, whether the factor to be determined is the point of *profit and break-even,* or the cost of *development and production.*

Where profit is unknown, Fig. 1(B), estimates calculated for plotting should be as accurate as possible. If these estimates are also conservative a clearer picture for decision will be obtained.

Factors from which these estimates are derived should include:

1. Projected Selling Price based on market potential and the competitive situation. It might also prove advantageous to establish minimum and maximum limits. *On the charts:* $26.50 per unit

2. Sales Potential based on competitive considerations such as market conditions, quality of product, and selling points. Range between minimum and maximum expectations should be included. *On the chart:* 1,500 units minimum; 2,000 units maximum

3. Development Cost

   a. Development engineering

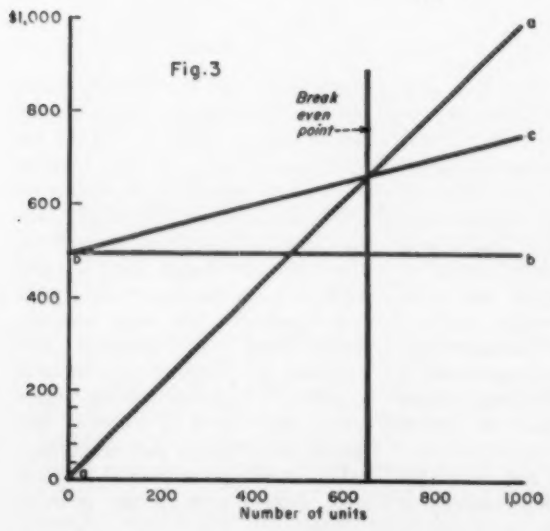
b. Development drafting
c. Pilot model or models
d. Preliminary testing
e. Allowances for modifications of drawings and models
f. Other pre-production costs exclusive of tools and facilities
On the chart: $7,500.00

4. Cost of New Tools and Expansion of Facilities
On the chart: $3,400.00
5. Manufacturing Cost *On the chart*: $15.85 per unit

When the last factor has been incorporated in the chart, the economic survival of the product is more evident. If the position of the break-even point permits an acceptable profit despite the conservative estimates—and adverse price and market conditions based on lowest selling price and minimum sales potential—the product can be considered worth investment and further development can be justified.

If the break-even point indicates a marginal return or a loss, the project may warrant modification, but in all likelihood, it should be dropped. As actual development progresses or important modifications are made, the new data obtained can also be charted so that if the break-even point does fall beyond safe economic limits, that fact will be brought out. In Fig. 1(B) the location of the break-even point indicates that profit will begin at considerably less than the minimum sales potential.

Where development and production costs are being determined, Fig. 1(A), the chart can show whether economic restrictions imposed by a required profit and break-even point are prohibitive. Assume that the sales force advises the engineering department of a customer's request for the production of a new device with a total sales potential of 1,000 units and a total price of $100,000.00. Management has given a conditional approval based on the assurance of a ten percent minimum profit and a break-even point at 500 units. Plotting the limitations shows the engineer that approximately $9,000.00 must cover costs of development, tooling and facilities, and manufacturing. This data combined with experience will then enable him to advise Management as to the practicality of the project.



Other Uses for Chart

The flexibility afforded by the break-even chart can be applied to a variety of other engineering problems in addition to new product analysis.

Equipment Selection: The break-even chart is a practical means of comparing two or more sets of data. In determining which of two machines is more economical, Fig. 2, the fixed cost of the equipment is plotted with the unit production cost achieved with each:

	Machine A	*Machine B*
Initial Cost	$1,500.00	$6,000.00
Unit Production Cost	.75	.15

The chart shows that it is more economical to purchase Machine A if production will not exceed 7,500 units. For higher quantity production the economy lies with Machine B. The selection of equipment will, therefore, depend upon the sales forecast, production schedule, obsolescence of product, or depreciation and maintenance factors.

Mechanization Substitution: Break-even charts offer a particularly convincing argument of their effectiveness when employed to show the advantages of mechanized production over those of hand labor. Assume that a new wrapping device, costing $500, is being considered for a job where 1,000 units are handled yearly. Complete manual labor costs per unit total about one dollar, but the use of the wrapping device is expected to reduce the labor cost to 25 cents. The "break-even" chart, Fig. 3, is constructed quickly from this data. Line b-b represents the fixed cost of the device, line b-c its labor cost, and a-a the hand labor costs. The intersection of a-a and b-c is the break-even point—at approximately 670 units the wrapping device is paid for and mechanization is indicated

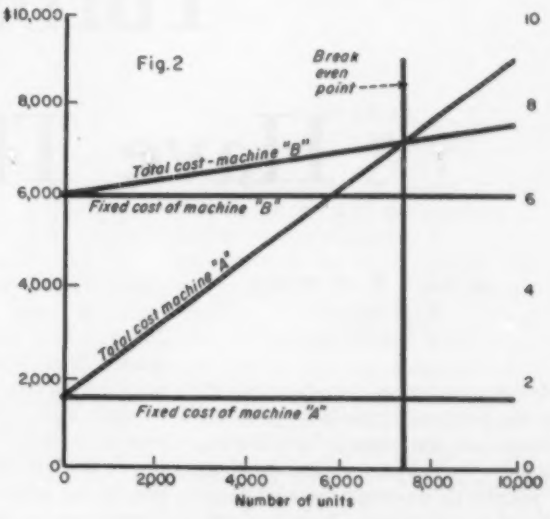
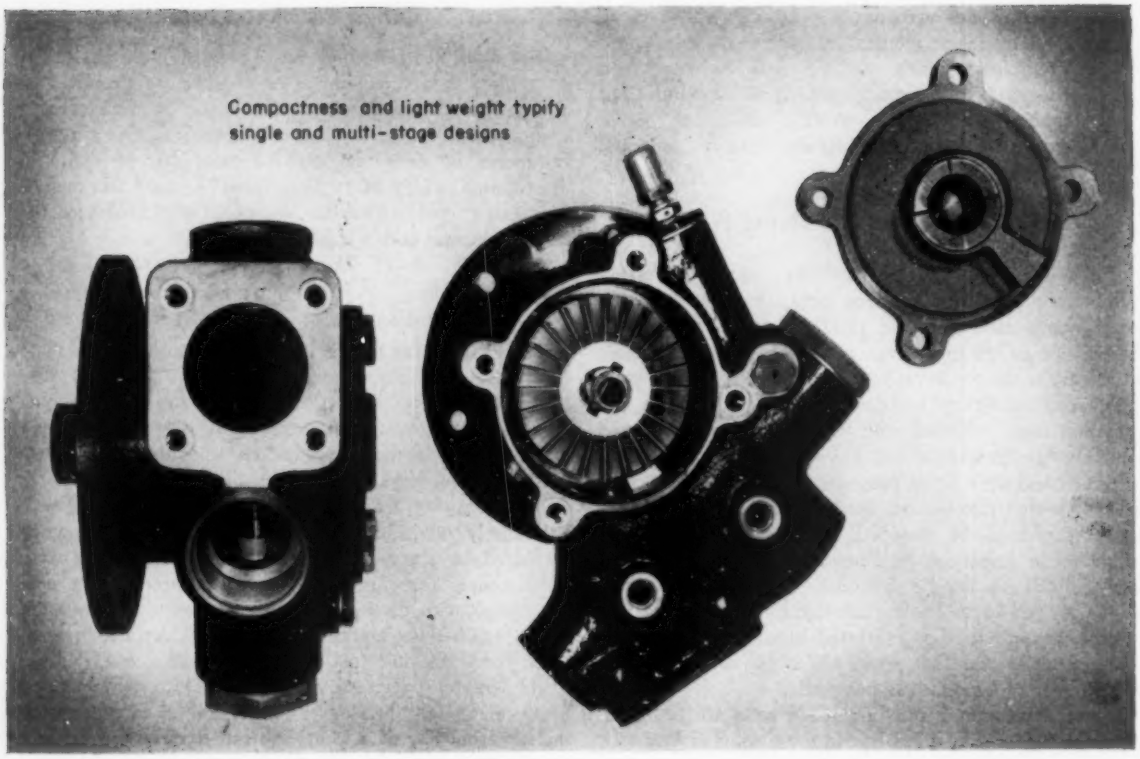


Fig. 2—Selecting Equipment. Fixed cost of equipment is plotted with unit production cost. Choice is determined by production.

Fig. 3—Mechanization substitution. Intersection of device's labor cost and previous hand labor cost represents break-even point.



Turbine Pumps Have Their Niche

ARTHUR B. OLMORE
Project Engineer,
Adel Division,
General Metals Corporation

ALTHOUGH the name "turbine pump" is the one most commonly used, this design is also known as "Westco-type", "turbulence", "regenerative", "peripheral" or simply "rotary" pump. Being of the impeller type, it is similar in construction to a centrifugal pump, but its operating principles are quite different and most of its performance characteristics approach those of the positive displacement pump.

Because of a general lack of understanding of their performance and operation, turbine pumps have been neglected in many applications where they may have proved to be the best suited. With performance characteristics overlapping those of both centrifugal and positive displacement pumps, a turbine pump usually will not do any job that cannot be done by one of the other designs. But when factors such as size, weight, cost, operating speed, wide performance range and dependability are considered, it will frequently fulfill requirements more satisfactorily than the better known types.

Turbine pumps are best suited for pumping liquids of low viscosity at relatively high head, moderate capacity and low shaft speeds. Typical applications in the industrial field are for boiler feed, condensate, high pressure wash water, general water circulation (both fresh and salt), chemicals, gasoline, liquefied petroleum gas and oil. Their compact design, long life and stable performance characteristics make them applicable for many hydraulic system boost, water injection, anti-icing and fuel pumping applications in aircraft. As engine-driven fuel pumps where shaft speed is relatively low, they are often lighter and smaller than either centrifugal or positive displacement designs meeting the same re-

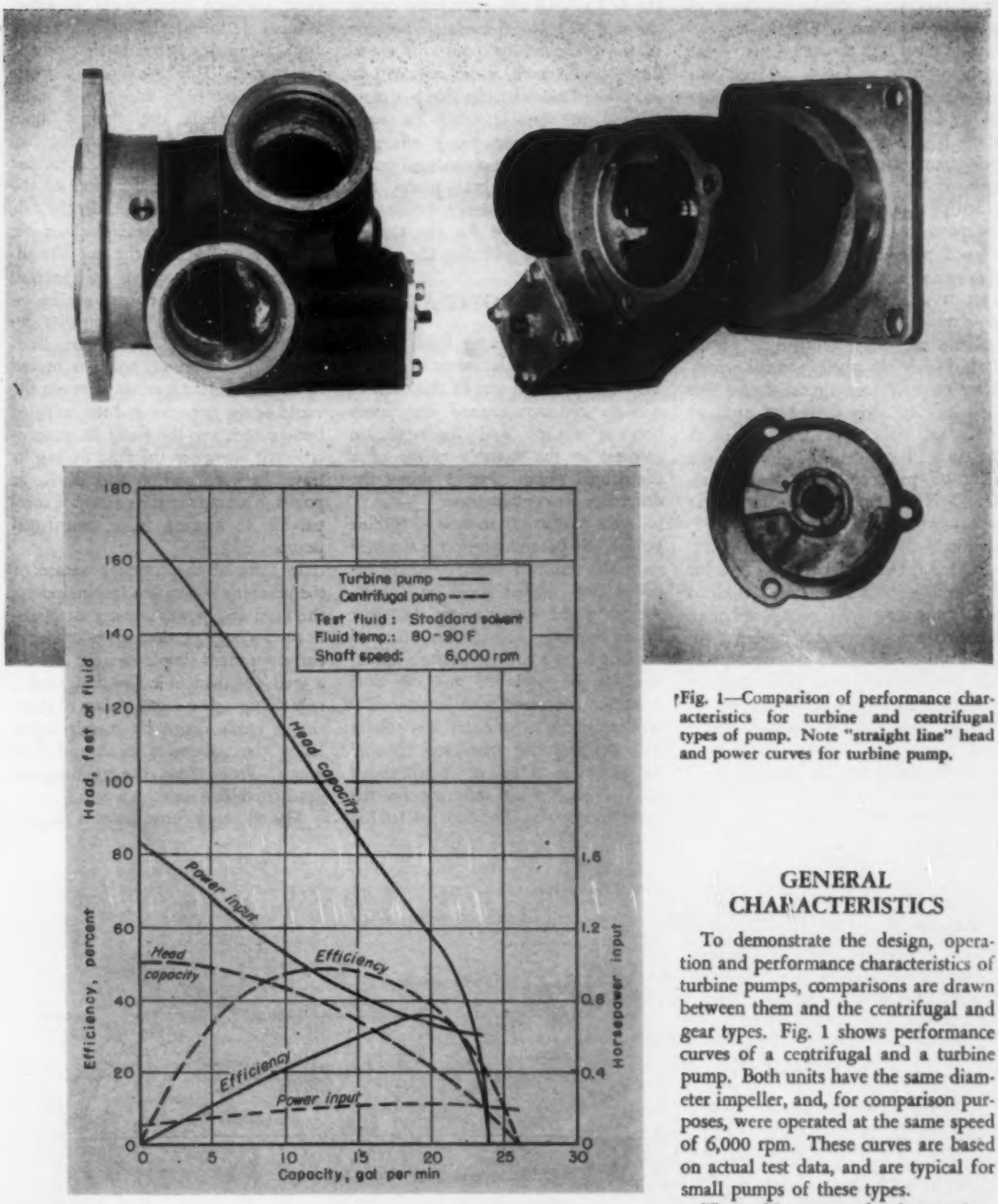


Fig. 1—Comparison of performance characteristics for turbine and centrifugal types of pump. Note "straight line" head and power curves for turbine pump.

quirements. They are adaptable to direct drive by standard a-c motors turning at either 1,750 or 3,500 rpm, as well as to conventional aircraft motors, either a-c or d-c, where the operating speed is in the 3,000 to 10,000 rpm range.

Although the principal application for turbine pumps in the past has been for pumping low viscosity liquids, theoretical analysis and test data indicate they have considerable promise for handling liquids of high viscosity, especially at low pressures;[1] centrifugal pumps exhibit low efficiency when handling viscous fluids.[2]

GENERAL CHARACTERISTICS

To demonstrate the design, operation and performance characteristics of turbine pumps, comparisons are drawn between them and the centrifugal and gear types. Fig. 1 shows performance curves of a centrifugal and a turbine pump. Both units have the same diameter impeller, and, for comparison purposes, were operated at the same speed of 6,000 rpm. These curves are based on actual test data, and are typical for small pumps of these types.

The turbine pump develops a shut-off head several times that of the centrifugal pump, and has high capacity characteristics throughout a wide range of head. Maximum capacity is about the same for both. Thus, for any given change in head, the capacity of the centrifugal pump varies over a much wider range than that of the turbine pump. In this respect, turbine pump

head curves are similar to those of positive displacement pumps.

The head and power curves of the turbine pump in Fig. 1 are not only essentially straight lines, but also slope in the same direction. This downward slope is also typical of the head and power curves of positive displacement type pumps. The head curve of the centrifugal pump is much flatter, while the power curve slopes upward. The shut-off pressure of a turbine pump is always its maximum, and its performance is steady over the entire curve, even under mild cavitation conditions.

Head curves of centrifugal pumps vary widely in their general form. They normally are almost flat at low capacities, or show a shut-off pressure somewhat higher than the balance of the curve; but a "rising" characteristic (shut-off pressure lower than maximum) is not uncommon. The latter type is usually unstable as shut-off is approached.

The shape of the efficiency curve for the turbine pump, Fig. 1, is similar to that of the centrifugal pump, although it shows a much greater tendency toward straight lines and a sharper peak. The best efficiency point of the turbine pump occurs at about 80 percent of maximum capacity, while the centrifugal pump has its best efficiency at about the mid-point. A gear pump efficiency curve normally is fairly flat throughout a wide range of head, with the best overall efficiency point nearer the shut-off end. The relative position of the best-efficiency point for a turbine pump is fixed, within narrow limits, while the centrifugal pump is more flexible in this respect. To summarize, the turbine pump efficiency curve is pointed, the centrifugal pump rounded, and the gear pump flat. Thus, from the efficiency standpoint, the operating range for the turbine pump is more limited than the others.

THEORY OF OPERATION

A section through the fluid passage of a turbine pump is shown in Fig. 2. The cross-sectional area of this channel remains constant around the pump between suction and discharge, in contrast to the variable volute of a centrifugal pump. Fig. 3 shows the difference in configuration.

In the theoretical analysis of turbine pumps, the pumping action is assumed to be the result of relative motion between two parallel walls, one represented by the impeller and the other by the housing. Though the rotor and housing form a circular passage, curvature can be neglected and the flow condition compared with laminar flow between infinite parallel flat plates with the impeller vanes and channel configuration affecting performance only through their influence on the correction factors. The flow pattern has been analyzed theoretically as either laminar or turbulent, but in practical applications, it appears to lie closer to the former. This conclusion is made because most head and power input curves approach the straight lines based on laminar flow theory.

The head developed by a turbine pump is primarily a function of the channel proportions, especially the side clearance, *a* and the radial clearance, *b*, Fig. 2, rather than the impeller diameter and shaft speed. In contrast, centrifugal pump performance is essentially dependent upon impeller design and speed. The high head capacity of a turbine pump is caused by the recirculating action between the vanes of the impeller and the walls of the channel, and the resultant accumulation of energy in the fluid during its travel between suction and discharge points. This regenerative action is comparable to staging in a centrifugal pump.

In spite of the complex nature of the pumping action in a turbine pump, the head and power input characteristics and a large portion of the efficiency curve approach simple straight lines in a well designed unit. In designing a new pump, advantage is taken of these simple curve forms by merely calculating the maximum head and flow points. From these, the approximate head curve is drawn.

The efficiency curve can also be esti-

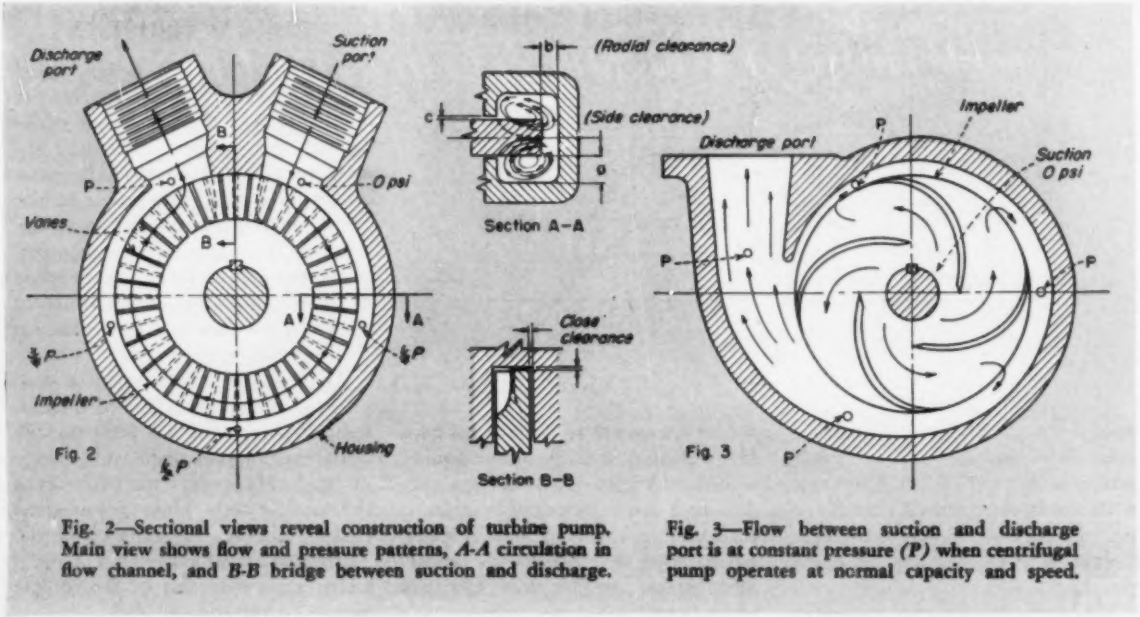


Fig. 2—Sectional views reveal construction of turbine pump. Main view shows flow and pressure patterns, *A-A* circulation in flow channel, and *B-B* bridge between suction and discharge.

Fig. 3—Flow between suction and discharge port is at constant pressure *(P)* when centrifugal pump operates at normal capacity and speed.

mated, although it is difficult to predict how closely the actual efficiency will follow the normal line before deviating and returning to zero. This is determined by channel and impeller proportions, and other design details.

Head and Discharge Characteristics. As shown in Fig. 4, the typical head curve is nearly a straight line. In many cases it falls off somewhat as it approaches shut-off pressure, the dotted lines showing the normal path. This deviation usually does not occur to any appreciable degree at shut-off heads of less than 150 ft, but does become more pronounced at higher pessures. Unless caused by improper channel and impeller design, this condition is caused by clearance around the impeller at the bridge, with clearance c (Fig. 2) having some effect. Thus, it is desirable to maintain clearances and tolerances as close as practicable, especially in the higher pressure pumps.

The head characteristic also may deviate from a straight line at low heads, as shown in Fig. 4, the dotted lines indicating the normal path. This is the result of partial cavitation. Since pump performance is still steady under incipient cavitation conditions, it is sometimes permissible to use the pump in this portion of the curve.

In a given pump design, the shut-off head varies approximately as the square of the shaft speed, and maximum discharge varies directly with the shaft speed, as shown in Fig. 4. As indicated above, however, the head curve is not fixed by impeller diameter and speed, and can be varied over a considerable range by changing the channel configuration. This feature sometimes can be used to advantage by providing replaceable pump liners to change performance. In contrast, the shut-off pressure of a centrifugal pump is almost entirely a function of impeller diameter and shaft speed, and the head curve itself is essentially a function of impeller design.

As in the centrifugal pump, specific gravity does not affect the normal head curve when plotted in terms of feet of fluid. Fig. 5 shows head characteristics for water, aviation gasoline and aircraft hydraulic oil. All three curves are closely grouped, in spite of appreciable variation in specific gravity. The effect of viscosity is not well understood, since test results do not wholly agree with theoretically derived formulas in this respect. It is apparent from a study of numerous test data that the head decreases as viscosity increases; however, for practical purposes, the effect is not appreciable within the limits of viscosity normally used. The ratio of absolute viscosity between hydraulic fluid and gasoline is approximately 30 to 1, yet the head curves are very close and tend to converge at zero head.

Single-stage turbine pumps are normally used for operating pressures to 200 psi and at discharge rates to 200 gpm, although pressures and flow rates beyond these values are not uncommon. Additional stages can be added

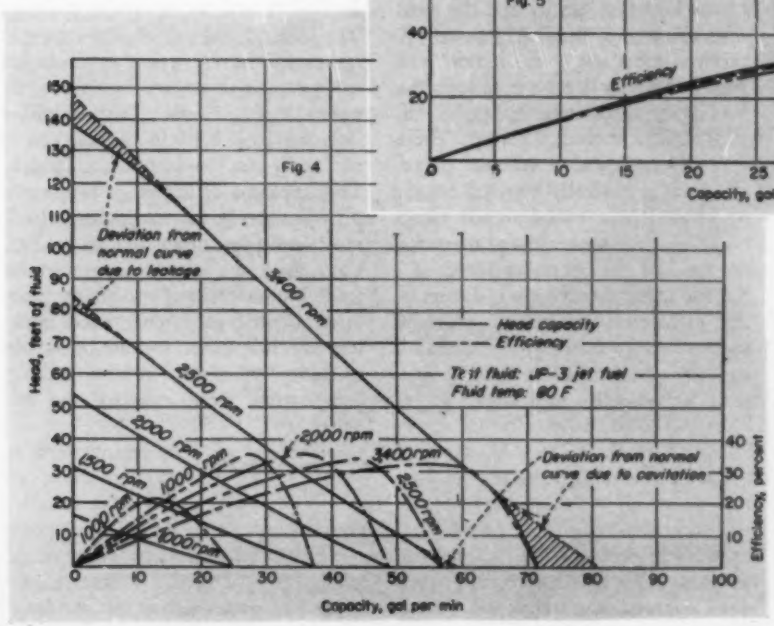


Fig. 4—Turbines pump performance characteristics as function of shaft speed. Deviations from normal curves caused by leakage and cavitation appear under higher head and flow conditions.

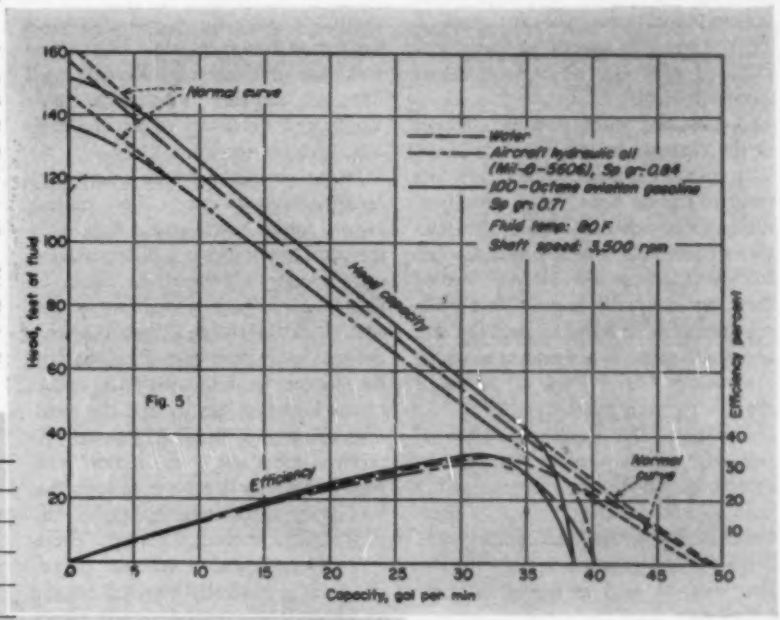


Fig. 5—Turbine pump performance characteristics as function of fluid indicate specific gravity has little or no effect on peak efficiency.

conveniently, but practical considerations such as efficiency limitations and the difficulty of minimizing internal leakage at the higher pressures through close tolerances, usually limit designs to two to three stages and the pressure rating to 500 lb per sq inch.

Suction Characteristics. A conventional turbine pump, like the centrifugal pump, has no dry suction, and will not prime itself with a negative suction head. Special designs have been devised wherein a fluid trap in the pump chamber permits self-priming, thereby taking advantage of its excellent wet suction characteristics. A turbine pump in cold water service is capable of operating at full capacity with 20 ft or more suction lift when fully primed.

Cavitation is primarily a function of impeller tip speed and vapor pressure. Shaft speeds suitable for pumping water are entirely unsuitable for gasoline. For the pump to operate properly, it is essential that an absolute pressure greater than the fluid's vapor pressure be maintained within the suction port at the entrance to the pump chamber. This pressure differential is called "net positive suction head," in practice generally abbreviated to NPSH. Satisfactory operation has been obtained with NPSH values as low as four feet of fluid, but it usually imposes severe design penalties in terms of impeller size and shaft speed to attempt to use such low values. An NPSH of 20 ft or more is recommended.

Efficiency. Disregarding possible effect of cavitation with light fluids, specific gravity has no apparent influence on peak efficiency. This is illustrated in Fig. 5, where efficiency curves for water and gasoline nearly coincide. Test data, as well as theoretical considerations, show that peak efficiency is inversely affected by viscosity. Since viscosity does not appear as a direct factor, the effect is relatively small, and a high peak efficiency can be realized throughout a wide range of viscosities. Limited test data on highly viscous fluids, such as lubricating oils, indicate that peak efficiency of 25 percent or more is possible. In the higher pressure pumps, fluids of low viscosity show a relatively low peak efficiency, presumably because of generally decreased lubricity and greater internal leakage at the bridge between discharge and suction.

The peak overall efficiency is relatively independent of speed, until cavitation becomes a factor at the higher values. Even comparatively low speeds do not reduce efficiency. Some test data indicate that it actually increases as speed is reduced, approaching the theoretical maximum at very low rates. As the small mechanical losses become a major factor, there is a practical limit to which speed can be reduced before efficiency begins to drop. Tests have been made where maximum overall efficiency still exceeded 25 percent with an impeller tip speed of only 10 ft per second. Further reduction of speed caused a rapid decline. This ability of a turbine pump to maintain its efficiency at a very low speed is of some interest, but has little or no practical value other than to extend the range of acceptable operating speeds insofar as efficiency is concerned. In most designs, the objective is to operate at the maximum tip speed commensurate with good design practice in order to make the unit compact. Even a small two-inch impeller turning at only 1,000 rpm has a tip speed of nearly nine feet per second.

Being an impeller type pump with no friction losses except those of disk friction, shaft bearings and fluid seals, the turbine pump has a high mechanical efficiency. However, the maximum hydraulic efficiency is less than 50 percent. It can be shown theoretically that the maximum flow rate is one-half of the rate corresponding with the product of the impeller velocity and the cross-sectional area of the fluid channel. As this maximum rate occurs at zero head, where efficiency is zero, it follows that maximum theoretical hydraulic efficiency cannot exceed 50 percent. Therefore, the practical maximum overall efficiency is generally between 30 and 45 percent in a well-designed pump.

Operating Speed. The primary factor limiting the operating speed of a turbine pump is cavitation, disregarding extraneous mechanical problems such as bearings, strength of materials and shaft seals. Water pumps operating at normal temperatures at sea level usually run at impeller tip speeds of about 50 ft per sec. However, if the pump is used only in the high pressure range of the head curve where cavitation does not exist, speeds considerably in excess of 50 ft per sec can be used. This is advantageous when small size and low weight are of importance.

The low operating speed range permits direct drive with conventional a-c or d-c motors of both commercial and aircraft type. This is one of the greatest assets of turbine pumps in applications where relatively high head and low capacity are required. As compared with centrifugal pumps, multistage performance is obtained with a single stage.

In aircraft applications, the compact design and low weight of turbine pumps are attractive features. Because materials used in construction normally do not require any particular high strength or low friction properties, the entire housing and pump chamber can be made of aluminum or magnesium alloys. While non-ferrous alloys can be used for the impeller, steel is recommended to better withstand momentary shock loads on the vanes imposed by foreign particles in the fluid.

The simplicity of design makes the manufacturing cost of turbine pumps much lower than that of positive displacement types. Having no extremely close clearances and requiring little space lengthwise, it is common practice in the smaller pumps to extend the motor shaft and mount the impeller on the end. This obviates the need for a coupling between the pump and the motor, and in many cases, greatly simplifies shaft seal design. Such practice would be impossible in the case of a gear or a vane pump because of the extreme difficulty in maintaining close enough tolerances to avoid binding. The critical nature of the channel makes the turbine pump a somewhat more expensive design than a centrifugal pump. Further, the impeller does not lend itself to casting, and is ordinarily machined from solid stock. This apparent disadvantage frequently proves to be an advantage for experimental purposes or for limited production, since the entire pump can be made by conventional machining processes. Centrifugal impellers and housings are difficult to fabricate by simple machine operations, thereby making experimental work awkward and expensive.

Versatility of port arrangement is sometimes an advantage in favor of a turbine pump, especially in installations where space is limited. The ports can be placed in various positions or relationships. The only precaution necessary is to avoid restrictions and long passages in the suction port in order

to prevent cavitation. In centrifugal pumps the suction port must come into the center of the impeller.

Symmetry of the pumping chamber of a turbine pump permits reversal of flow by reversing direction of rotation. This feature is sometimes advantageous.

Although the maximum possible efficiency is comparatively low, it is important to note that over the operating range for which it is intended, a turbine pump is usually more efficient than a positive displacement pump for that same range, and the smaller units compare favorably with centrifugal pumps. For handling viscous fluids it may well be the most efficient type.

Other advantages of more or less importance, depending on the application, are: Ease of staging, wide operating speed range with little variation in peak efficiency, ability to pump nonlubricating fluids, ability to run dry for long periods of time, and low shut-off pressure compared with positive displacement pumps (avoiding the possible need for relief valve protection in case of a momentarily blocked discharge line). A turbine pump usually will not generate enough pressure at shut-off to damage itself or the system.

Limitations. The limited usage of turbine pumps cannot be attributed entirely to lack of familiarity with their characteristics, or to unavailability. Undoubtedly the greatest handicap is low efficiency. Even in applications where efficiency is not of primary importance, there is a natural aversion to using a mechanism whose peaks efficiency cannot exceed 40 or 45 percent. In the case of large pumps, where power absorption is considerable, such low efficiency cannot be tolerated.

Like the centrifugal pump, the conventional turbine pump has no dry suction characteristics; it can be used only with a positive suction head. This factor frequently limits the selection to a positive displacement pump, even though it is inferior in other respects.

In many commercial applications, low cost is of paramount importance, even to the point of making all other factors secondary. Some form of centrifugal or axial flow pump is invariably used in such cases, since they are inherently cheaper to manufacture, especially in large quantities. The relatively close clearances necessary in a turbine pump require considerably more machining than is necessary in a simple centrifugal pump.

Turbine pumps cover a relatively small range of performance characteristics in terms of head and capacity as compared with centrifugal and gear pumps. For example, in very general terms, gear pumps can be used for pressures from 100 to 2,000 psi, and at capacities to 100 gpm; centrifugal pumps can be used for pressures to 400 psi and at capacities to 10,000 gpm. In comparison, the 500 psi 200 gpm range for turbine pumps is narrow.

The operating principles and performance characteristics of centrifugal and positive displacement pumps are generally well recognized. A similar understanding of turbine pumps would permit better choice of the most appropriate design for a given set of conditions, especially in many applications where neither a centrifugal nor a positive displacement pump is wholly satisfactory. In such cases, the "intermediate" performance of the turbine pump may be best suited for the requirements. Although they have a reputation for poor efficiency, within their normal operating limits, properly designed turbine pumps often compare with or exceed these other types in overall efficiency. Their best efficiency point is far less sensitive to wide variations in shaft speed, fluid properties and size of unit.

The following example, Fig. 6, illustrates a typical application for which a turbine pump is considered the best design. An aircraft engine-driven pump was to deliver 60 gpm of jet fuel at 300 psi (900-ft head, using fluid of 0.77 sp gr) with a drive shaft speed of 3,400 rpm. This speed would have been too slow for direct drive of a centrifugal pump without staging, and too fast for a positive displacement pump of such high capacity. Other physical requirements of the unit made gearing of the drive shaft impractical. A turbine pump with approximate envelope dimensions of 8.5-in diameter and 5-in. length (exclusive of ports) and an overall efficiency of almost 40 percent was chosen.

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(1) Warren E. Wilson, "Analysis of Turbine Pumps". *(Product Engineering,* October, 1947).

(2) A. T. Ippen, "Influence of Viscosity on Centrifugal Pump Performance". (Paper No. A45-57 ASME).

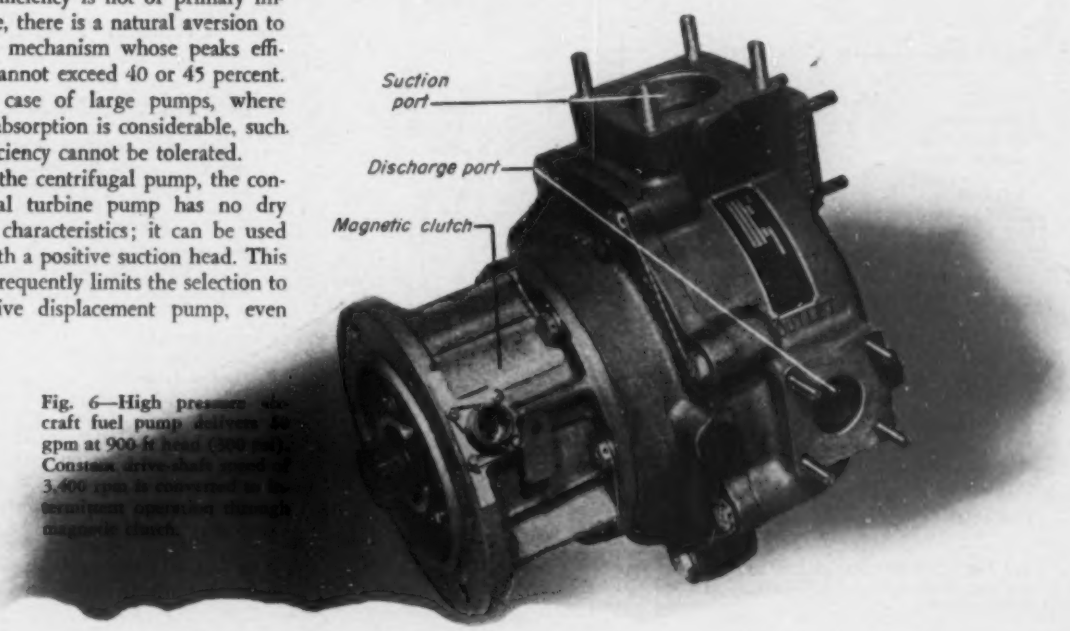


Fig. 6—High pressure aircraft fuel pump delivers 60 gpm at 900 ft head (300 psi). Constant drive-shaft speed of 3,400 rpm is converted to intermittent operation through magnetic clutch.

Dynamic Braking

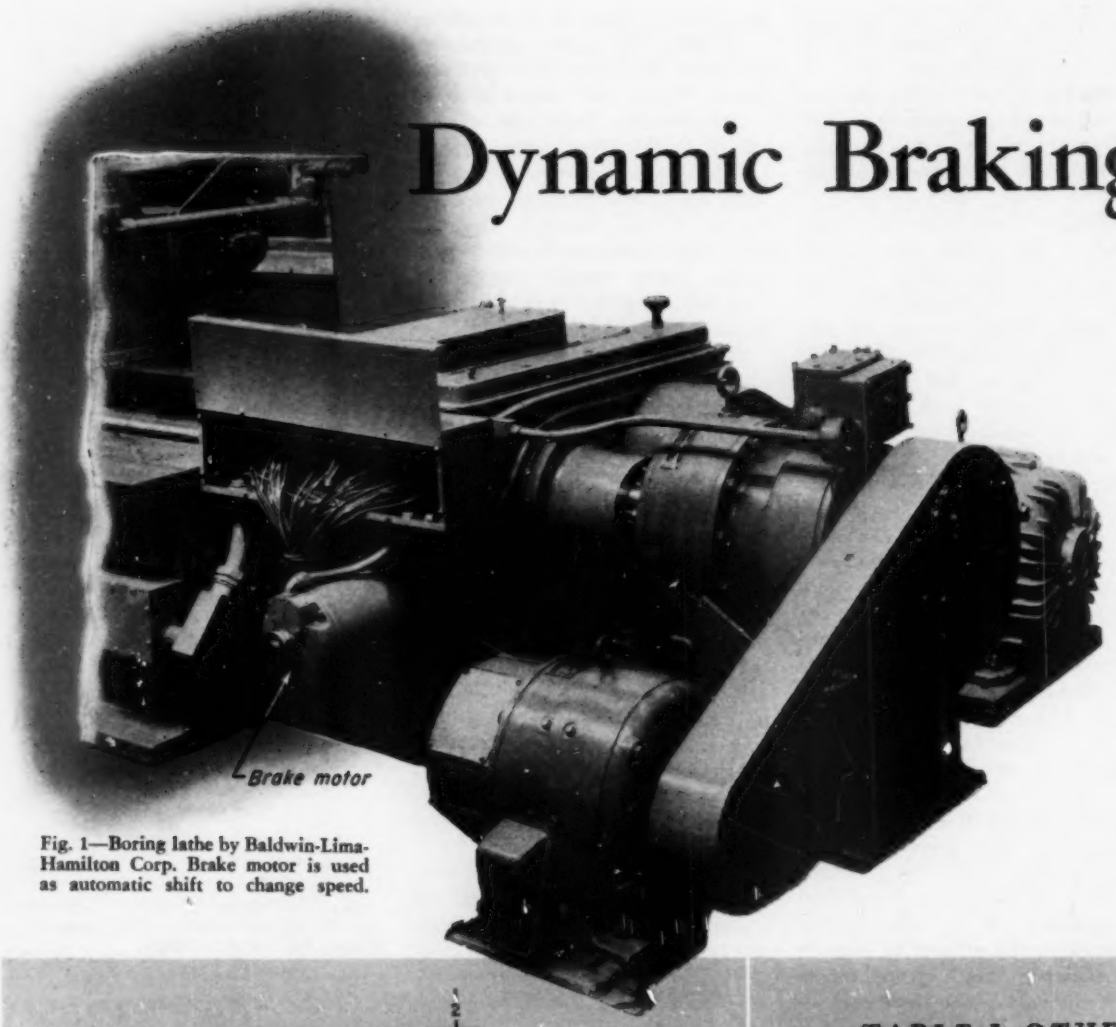


Fig. 1—Boring lathe by Baldwin-Lima-Hamilton Corp. Brake motor is used as automatic shift to change speed.

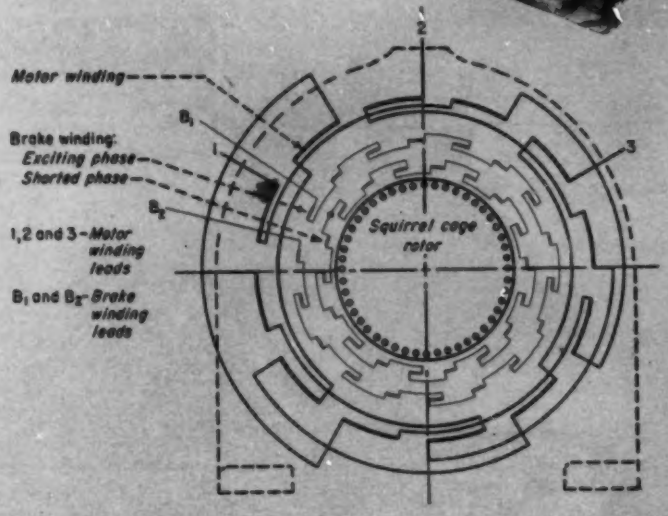


Fig. 2—Schematic connection diagram showing dynamic braking winding superimposed on standard squirrel cage windings.

TABLE I—OTHER

DISK FRICTION BRAKES

The most common brake motor package consists of a standard motor with a spring set—magnetically released friction brake. Several spring loaded metal plates are mounted on the motor shaft and turn with the rotor. When the motor is energized, magnets hold these plates away from the stationary disks of friction material and the rotor is free to turn. When the motor is de-energized, the springs force the plates against the friction disk, braking the rotor.

Since the coefficient of friction of the brake material is affected by temperature, humidity, oil, moisture, and age, consistent accuracy in stopping is not always possible. Also, corrections must be made for the wear of the friction material, changes in spring constants and variations in

# of Squirrel Cage Motors

By incorporating dynamic brake windings in standard frame size motors, many common braking problems can be solved and brake motors can be used in certain applications where they were heretofore thought impractical.

SAMUEL NOODLEMAN
General Manager, Standard Electric Div.
Standard Dayton Corporation

DYNAMIC BRAKING offers one solution to the problem of obtaining fast, low cost, and maintainance-free braking characteristics with a-c squirrel cage motors. Space requirements are lower than with other braking methods, Table I, since the brake windings can be superimposed on the stator windings in standard frame size integral and fractional horsepower motors. While dynamic braking is not suitable if the rotor must be held stationary against overhauling loads, it is applicable to all other braking applications particularly where gears are shifted during the rolling period approaching the final stop. Since the braking power is taken directly from the motor lines, the controls are simple and compact.

BRAKING PRINCIPLE

The brake winding consists of a multi-polar two phase winding, Fig. 2, superimposed on the standard stator winding of a squirrel cage motor and designed so that it is noninductively coupled with the motor winding. One phase of the brake winding is shorted on itself, or where large braking torques are required it is connected to an electrolytic capacitor. The other phase is energized from the a-c line during the braking process.

The dynamic braking action is divided into two essentially different operations as the speed of rotation is reduced. When the rotor speed is above the synchronous speed of the multi-polar braking winding, braking is mainly induction generator action, feeding power back into the line, Fig. 3 (A). Below this speed the rotor feeds power into the short circuited phase continuing the braking action down to zero speed. This transfer of energy is smooth and continu-

METHODS OF BRAKING A-C INDUCTION MOTORS

magnet coil resistance with temperature. Since the spring pressure is constant while the pull of the magnets varies as the square of the voltage, under-voltage conditions can lower the pull of the magnet to a point where the plates ride against the friction disks.

When a-c magnet coils are used, a magnetic hum is introduced into the motor. This can be objectionable where vibrationless operation of the machine is required to obtain a smooth cut or fine grind. The use of d-c coils does away with the hum, but involves an additional cost for rectifier units if d-c power is not available.

These brake motors are usually between 20 and 30 percent longer than standard integral horsepower motors of the same frame and rating. In fractional sizes, they are from 30 to 40 percent longer than standard motors of the same rating.

Some type of mechanical contact brake similar to this must be used when the rotor is to be held stationary after it has been stopped. For example, when the motor is subjected to overhauling loads.

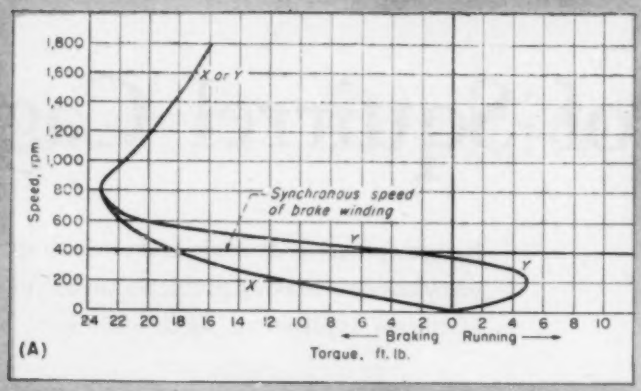
PLUGGING

For plug stopping, reversing starters are used to apply voltage of the reverse phase to the terminals of a polyphase motor. This results in a braking torque. When the rotor approaches zero speed, a zero speed switch, which is mechanically coupled to the motor, disconnects the motor from the line. While this method gives rapid braking performance, the cost involved in the reversing starter and zero speed switch often makes it impractical, particularly for smaller size motors. There is also the possibility that reverse rotation will occur because of inconsistencies in either the zero speed switch or reversing starter.

DIRECT CURRENT BRAKING

The application of d-c to one or more sets of a-c motor terminals will produce a braking effect. This method insures a stop without reverse rotation and without wear. However, if d-c is not available, the required rectifier equipment will be expensive. On high speed motors the braking torque is low while the rotor is turning at the top speeds. This results in a long braking period. To prevent overheating, some means must be supplied to disconnect the d-c from the motor windings after the rotor has stopped as it would cause overheating if continuously applied.

Fig. 3—Performance characteristics of 3 hp, 220/440 volt, 3 phase, 60 cycle, 1725 rpm squirrel cage motor with dynamic brake winding in which shorted phase is connected to a capacitor. In (A) is shown braking torque versus speed. Curve *X* represents normal braking action while curve *Y* shows motoring action which would occur if shorted phase was open. The voltage across the capacitor and current in the energizing winding are shown in (B). Note smooth transfer of energy from induction generator action into capacitor phase as the rotor approaches the synchronous speed of the brake winding. The curves in (C) show the motoring characteristics of this standard motor. These are not affected by the addition of dynamic braking.



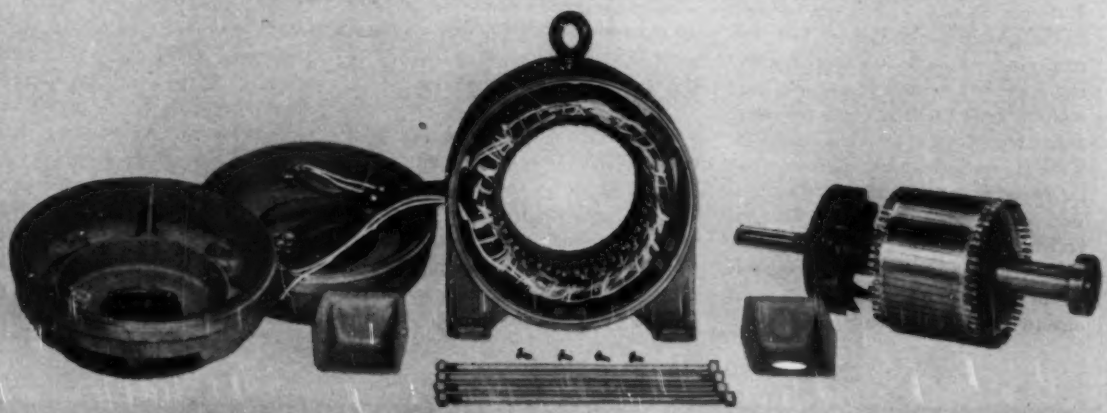


Fig. 4—Exploded view of brake motor. This is a standard motor with regards to frame size, horsepower and electrical performance, with minor variations in components to obtain the motor and braking characteristics.

ous, giving the same qualities to the braking process. Because of the time required for the build-up of the braking field, there is no sudden shock and instantaneous peak torques do not occur at the start of the braking operation.

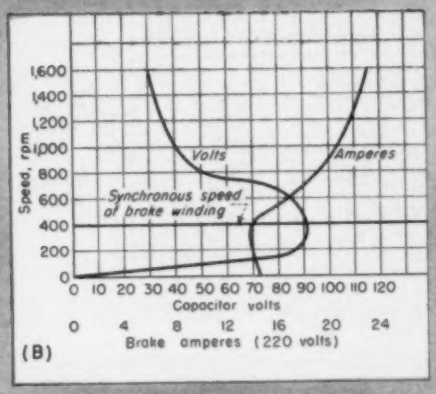
The characteristics of this braking system without the short circuited phase or with an open phase are shown by curve *Y*, Fig. 3 (A). This shows that such a condition would reduce overall braking performance and cause motoring similar to normal single phase operation.

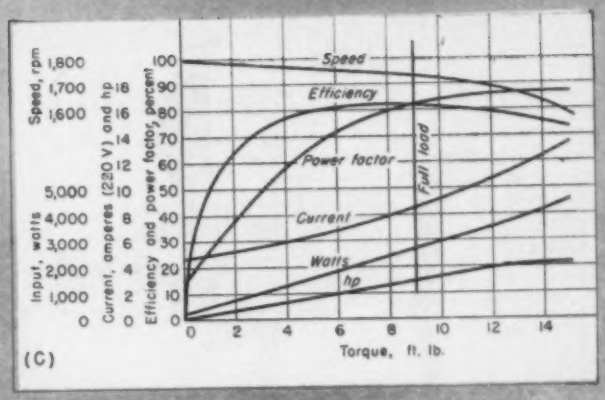
In Fig. 3 (B) is shown the voltage across the brake winding capacitors and the exciting current in the energizing phase during the braking operation. These curves show how the braking energy is transferred from induction generator action into the capacitor phase as the rotor approaches the synchronous speed of the brake winding. Since the voltage across the capacitor is never above 110 volts and occurs for a short interval, it is possible to use standard motor starting electrolytic capacitors for this purpose. This gives the advantage of small size and low cost capacitors.

This type motor must be designed with consideration to its function as a brake motor. It is generally impossible to superimpose a brake winding upon a standard motor winding and obtain good braking performance. The rotor design, stator stack and motor and brake windings, Fig. 4, must all be properly balanced to obtain good motor performance as well as the desired braking characteristics. Once this brake winding has been determined for a definite rotor and iron lamination, it can be used for any number of motor designs either single or polyphase, and for any number of motor speeds since the brake winding is not inductive with the motor winding. Also, when a brake design has been determined for a definite frame this same design can be used for many motors in that frame size.

DYNAMIC BRAKING CHARACTERISTICS

The braking action can be controlled by varying the voltage applied





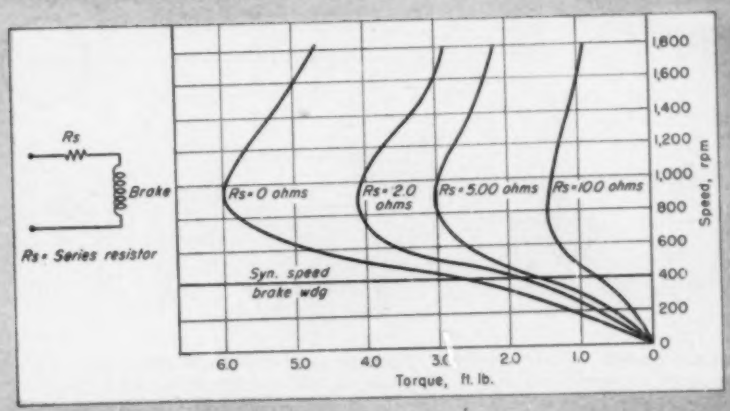


Fig. 5—Variation of braking characteristics as resistance is added in series with brake winding. Curves are typical of ½ hp, 115 volt, 1725 rpm capacitor start — induction run motor.

to the brake winding, since the braking torque varies as the square of the voltage limited only by the saturation of the iron. The most economical method of brake control is obtained by inserting a resistor in series with the brake winding to obtain the desired braking characteristics, Fig. 5. The braking action can be made infinitely variable through the use of a rheostat or other continuously variable voltage control.

The brake windings are designed for the same voltage rating as the motor, thus dual voltage motors have dual voltage brake windings. Similarly 50/60 cycle motors have 50/60 cycle brake windings. Since the brake winding is energized with single phase power, dual brake windings are supplied with four leads for either series or parallel connection, a normal practice with single phase motors.

In Table II is shown the dynamic braking torque available for general purpose motors of various ratings. All of these motors have the same frame and overall length as standard motors of the same rating. This not only reduces space requirements during original machine design, but permits the replacement of standard motors with dynamic brake motors in redesign projects without any increase in the space required by the motor.

Since the brake winding only causes a retarding action, there is no possibility of reverse rotation or backup of the rotor. This is desirable in applications where reversal would cause machine damage or a safety hazard.

With brake windings and possibly a capacitor being the only extra required equipment for dynamic braking, no special maintenance program is necessary over that applied to standard squirrel cage motors.

Table II—Average Braking Torques

(In percent of full load motor torque for standard open-continuous duty (40 C) 3 phase—60 cycle—squirrel cage motors

Motor Horsepower	Percent braking torque* for motors having synchronous speeds		
	3,600 rpm	1,800 rpm	1,200 rpm
¼	400	300	275
⅓	400	300	275
½	400	300	275
¾	350	275	250
1	300	225	200
1½	300	225	200
2	275	200	175
3	250	200	175
5	200	175	150
7½	200	150	...

*The average braking torque is the integral of the developed braking torque over the rotor speed range from full load speed down to zero speed.

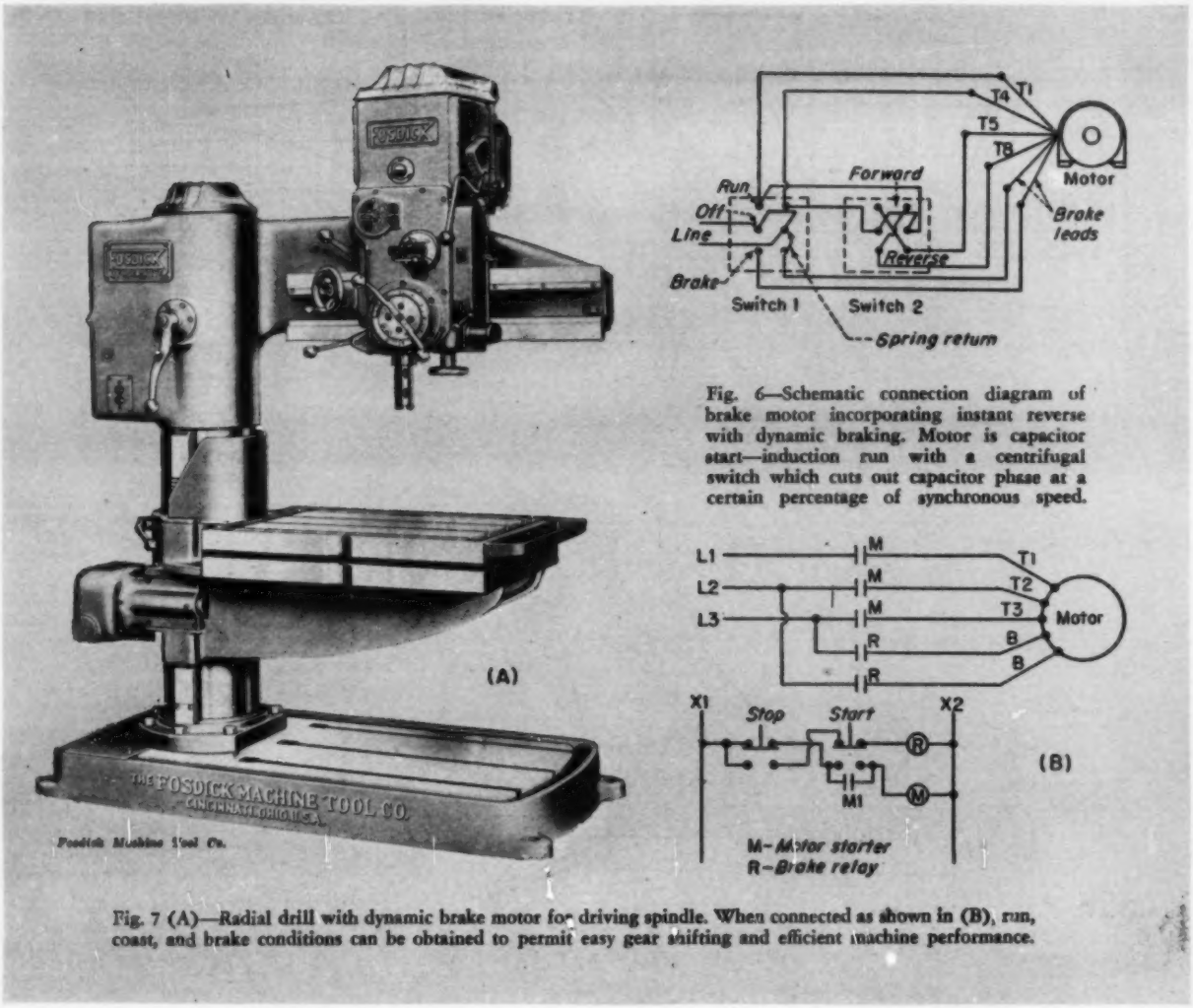


Fig. 6—Schematic connection diagram of brake motor incorporating instant reverse with dynamic braking. Motor is capacitor start—induction run with a centrifugal switch which cuts out capacitor phase at a certain percentage of synchronous speed.

Fig. 7 (A)—Radial drill with dynamic brake motor for driving spindle. When connected as shown in (B), run, coast, and brake conditions can be obtained to permit easy gear shifting and efficient machine performance.

APPLICATIONS

Because of its vibrationless operation, simple controls, and free rolling action while approaching the final stop, dynamic braking is used in many machine tool and special machinery applications. As stated previously, the rolling action is useful where the easy meshing of gears is required.

In Fig. 6 is shown the connection diagram for a capacitor start—induction run brake motor as applied to a small threading lathe. In this application not only run and brake connections are required but also instant reverse.

To reverse the motor, switch 2 is thrown from *forward* to *reverse* while the motor is running. Since the centrifugal capacitor phase switch is open, no action will occur. Then switch 1 is thrown to *brake* and back to *run*.

The momentary energizing of the brake winding reduces the rotor speed to the point where the centrifugal capacitor phase switch closes. Reverse motor torque is then applied to the rotor and its speed increases in the reverse direction. Switch 1 is spring returned to the *off* position from the *brake* position so that the motor cannot overheat from braking power while stopped.

In Fig. 7 is shown a radial drill utilizing a dynamic brake motor for quick stopping action to permit rapid and easy shifting of gears. The controls are simple and allow the operator to run, coast, or brake the machine for maximum machine performance. The machine is started by momentarily pressing the *start* button. The motor starter locks in through contact M_1. For coasting, the *stop* button is pressed momentarily de-energizing the motor starter. For braking, the *stop* button is held in. This energizes relay *R* and the dynamic brake windings.

A precision jig borer using motors with dynamic braking for automatically positioning the table within 0.0001 in. is shown in Fig. 8. When the operation is initiated, the table moves from left to right at a high rate and is braked to a stop as it approaches its final position. The table is then automatically moved slowly in the same direction and accurately brought to a stop at the required position. The rotor turns about one-half revolution in braking from 1700 rpm to zero speed. This corresponds to a

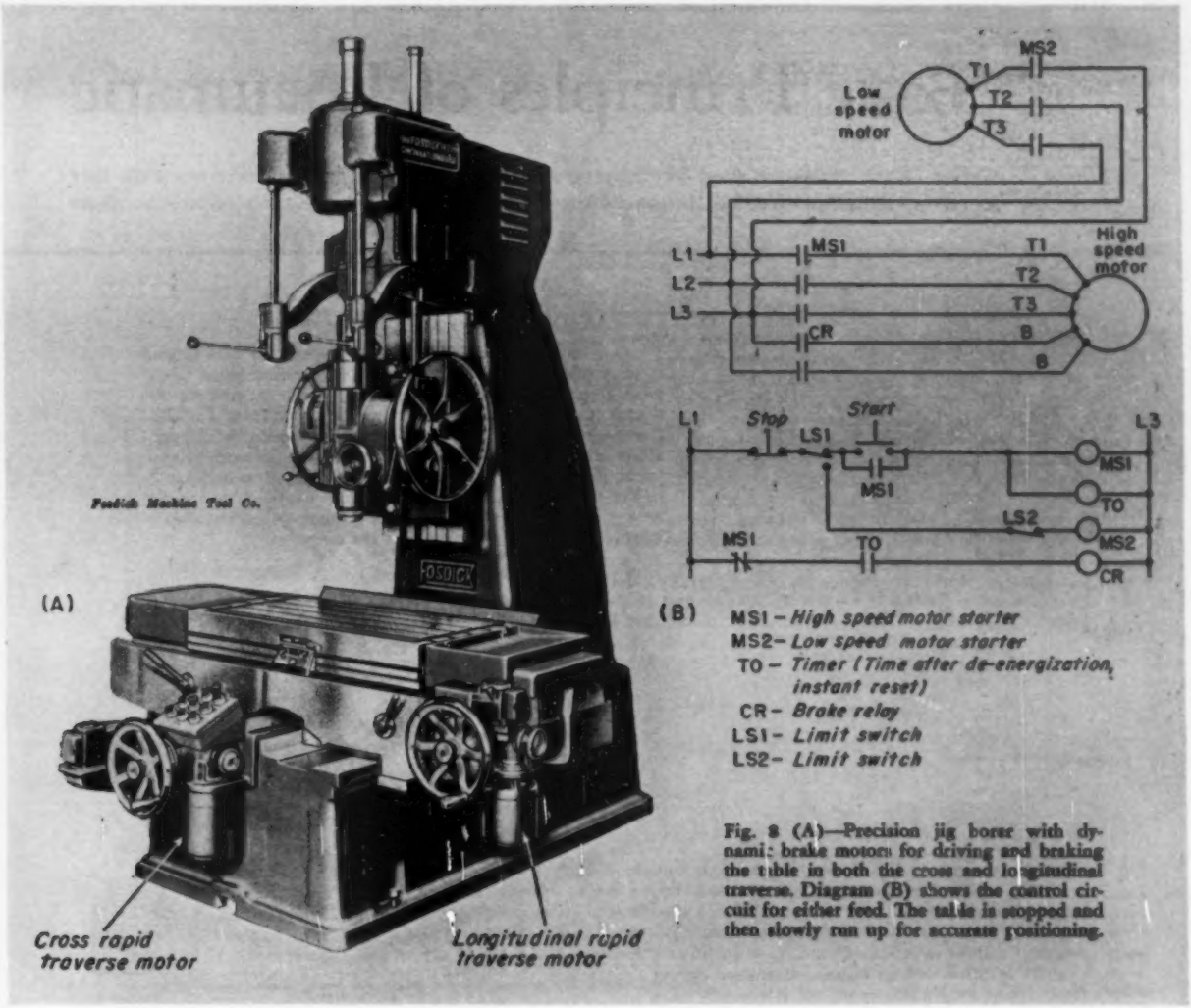


Fig. 8 (A)—Precision jig borer with dynamic brake motors for driving and braking the table in both the cross and longitudinal traverse. Diagram (B) shows the control circuit for either feed. The table is stopped and then slowly run up for accurate positioning.

reduction in table speed from 72 inches per minute to a full stop.

The operation is initiated by momentarily pressing the *start* button. The high speed motor starter, *MS*1, is energized and locks in through the normally open contact in parallel with the *start* button. When the table trips limit switch 1, the high speed motor starter and the timer are de-energized. The brake relay is energized since the normally closed *MS*1 contact is closed and the normally open timer contact, *TO*, remains closed for a preset period. The low speed motor starter is energized at the same time and takes over after the braking interval to drive the table to the final position. At this time limit switch 2 opens to complete the cycle. The return circuit is not shown.

The same type of operation occurs simultaneously in the other direction so that automatic positioning is obtained in both the longitudinal and cross traverse. The brake motor gives accurate positioning without shock and locking so that machine and thread strains are relieved.

This type of braking is also well suited to certain applications where braking has not been economically practical heretofore. For example, any machine on which both ends of the rotor shaft are utilized for driving purposes, such as pedestal grinders, can be equipped with braking for either functional or safety purposes. Similarly, in shell type shaftless rotor applications, where the stator and rotor are built-in as parts of the machine and the rotor shaft is not available for standard brakes, dynamic braking can be readily installed. Also, in totally enclosed or explosion proof motors, this type of motor represents a practical solution to the problem of obtaining an enclosed brake without increased cost since standard mechanical construction can be used.

In applications where a friction brake must be used, either as a safety precaution in the event of power failure or for holding purposes, dynamic braking can supply additional braking power. This cuts down the physical size of the friction brake and reduces maintenance costs and wear.

Thus, the dynamic braking of a-c motors is an economical method of obtaining quick, accurate motor stops, with flexibility of control, and ease of installation and maintenance.

Basic Principles of Pneumatic

Pneumatic operators are used for tripping alarms or shutting down processes when the safe operating limits are exceeded. In general they are placed in instruments such as pressure gages

Fig. 1

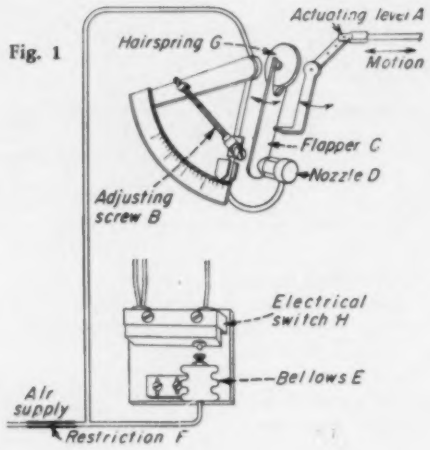


Fig. 1—Single switch consists of a flapper-nozzle unit linked to an actuating lever. Nozzle position or alarm point is set with adjusting screw *B*. When the nozzle is covered by flapper *C*, air fills the system expanding bellows *E*. This closes contacts in switch *H*. When lever *A* opens the flapper, air is released through the nozzle; bellows *E* contracts and opens the electrical circuit. A small orifice or restriction *F* in the supply side reduces the air flow required to operate the system. Hairspring *G* holds the flapper against the nozzle when the actuating lever is below the set point.

Fig. 2—This system actuates two alarms from a single motion and is normally used to indicate both high and low limits. Nozzles are on opposite sides of the flappers. When actuating lever *A* is in its safe position both flappers, *C* and *S*, are away from their respective nozzles *D* and *N*, and neither bellows *E* or *W* is filled. If *A* travels clockwise, flapper *S* covers nozzle *N* at its predetermined set point, causing bellows *W* to expand, and closing the contacts in the electrical switch *T*. This indicates that the high point has been reached. Since nozzle *D* is still uncovered, electrical switch *H* is not energized. When lever *A* reverses, nozzle *N* is uncovered, spilling the air from bellows *W* and the switch *T* opens contact. Thus, the unit is again in a safe position. When *A* rotates counterclockwise and hits the pre-set low point, the other switch, *H*, is energized.

Fig. 2

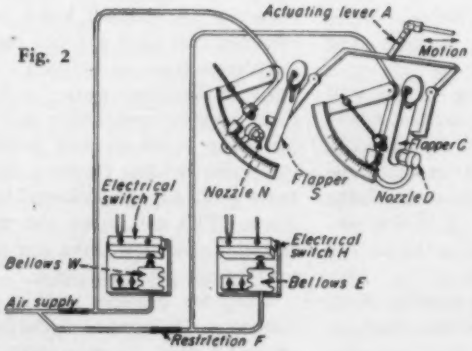


Fig. 3

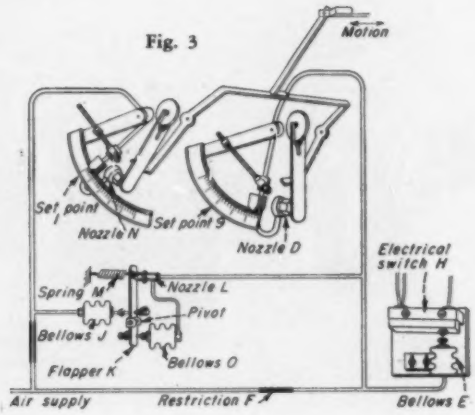


Fig. 3—Gap or interlock operator provides "on" and "off" action. Alarm cannot operate until the motion has passed through both set points from either direction. For example, if the control points were set at 1 and 9, respectively, action would be as follows. There is no air in either pusher-bellows *J* or *O* and the flapper *K* is held away from nozzle *L* by spring *M*. This leaves nozzles *D*, *N* and *L* uncovered and consequently there is no pressure built up in the device. When the lever starts forward, nozzle *D* is covered at set point 9, but nozzle *L* is still vented and no pressure is built up in bellows *E*. When lever reaches No. 1 setting, nozzle *N* is covered. This expands bellows *J* which pushes flapper *K* against nozzle *L* and, since nozzle *D* was already covered, pressure is built up in both bellows *J* and *O*, expanding bellows *E* and making contact in electrical switch H. The alarm is then energized indicating that the high point has been reached. The motion can now drop back to any point above the 9 setting, uncovering nozzle *N* and releasing the air pressure in bellows *J*. However, the pressure in bellows *O* keeps nozzle *L* covered or locked until the number 9 set point is reached, uncovering nozzle *D* and spilling the air from bellows *O* and *E*. This action requires a substantial change in position before the alarm is reset and prevents chattering around the high point.

Operators

HENRY MILO
The Foxboro Company

or thermometers, but they can be used in other devices wherever the available power is very small. Any of the units described will operate on less than 2 gram centimeters of torque.

Fig. 4

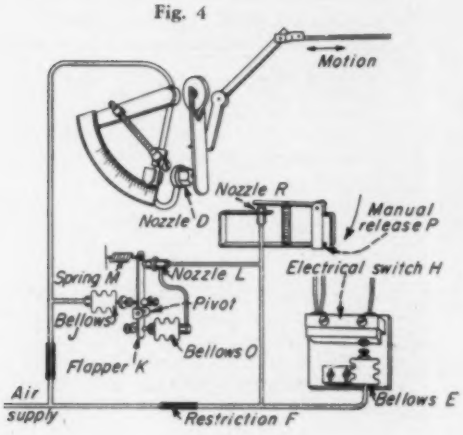


Fig. 4—Shutdown operation provides a warning signal when a predetermined measured value is reached. Signal will continue until the manual release switch *P* is pushed. A typical example would be as follows: At the start of the lever travel, nozzles *D* and *L* are uncovered and nozzle *R* is covered. When the set point is reached, nozzle *D* is covered, expanding pusher bellows *J* which forces flapper *K* against nozzle *L*. This expands both bellows *O* and *E*, operating the alarm. The lever can drop back to a safe position uncovering nozzle *D* but the alarm system is still under pressure due to the pusher bellows *O* covering nozzle *L* and the spring action covering nozzle *R*. Not until the operator manually pushes the release lever *P*, venting the air out of the system does the alarm shut off. When the air is vented, bellows *O* contracts and the flapper *K* is pulled back to bellows *J* by means of the spring *M*.

Fig. 5

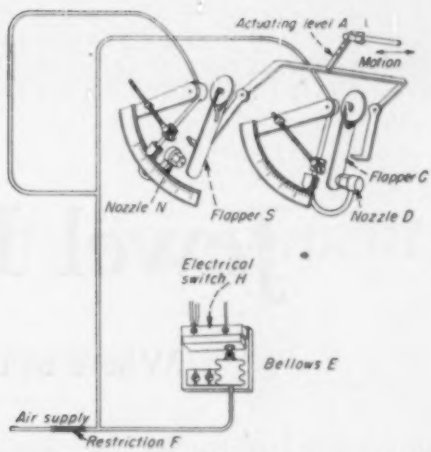


Fig. 5—Operator for actuating a common alarm from both the high and low limits of a single motion. Its action is similar to that of Fig. 2 except that both flappers *S* and *C* cover their respective nozzles when the motion is in its safe position. If either nozzle *D* or nozzle *N* becomes uncovered, the electrical switch *H* is energized.

Fig. 6

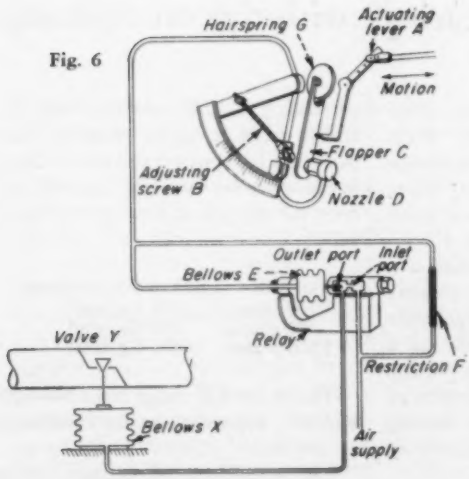


Fig. 6—Air valves can replace electrical switches when the function is to open (or close) a pneumatic line instead of sound an alarm. When the actuating lever *A* is below the set point, nozzle *D* is covered, air fills bellows *E* causing the relay plunger to shut off the inlet port. Air in the valve bellows *X* escapes through the relay outlet port and the valve *Y* is closed. When *A* reaches the set point, flapper *C* uncovers *D* and the bellows *E* collapses. This pulls back the relay plunger opening the inlet port and closing the outlet port of the relay. The air then fills the valve motor bellows *X* and opens the valve *Y*. Capacity of the bellows *X* is large in relation to the nozzle capacity *D* and a relay is generally placed between the valve bellows and the operator unit.

Table I—Properties of Jewel Materials

SYNTHETIC SAPPHIRE	
Melting point	2030 C
Hardness—Moh	9
—Knoop	1525–2000
Specific gravity	3.98
Dielectric constant	7.5–10.0
Compressive strength	300,000 psi
Maximum bending stress	94,000–100,000 psi (varies with angle of stress)
HARD BOROSILICATE GLASS	
Working point	1200 C
Specific gravity	2.53
Dielectric constant	7.2
Youngs' modulus	12.7×10^{-6} psi

Fig. 1—Typical meter movement in which jewel bearings are used to support the moving element. Because of their low coefficient of friction and non-magnetic properties, jewel bearings are ideally suited to applications such as this.

Jewel Bearings—*Precision*

Where to use jewel bearings, with tips on choosing

RANDALL P. CAMERON JR.
Manager, Richard H. Bird & Co., Inc.
Waltham, Mass.

JEWEL BEARINGS are used in low torque instruments and control devices whenever a low coefficient of friction, nonmagnetic properties and a long life expectancy are salient requirements. The materials normally used are sapphire and hard borosilicate glass. Sapphire is harder and more expensive than glass and is used for the more complicated bearing shapes and where heavy moving elements are to be supported.

The majority of the sapphire units are supplied by foreign sources, principally the Swiss producers, while glass jewels are available from domestic manufacturers. However, there are facilities in this country for small quantity production of sapphire bearings for test and experimental use. The domestic jewel bearing industry also inspects and mounts foreign made jewels and more or less acts as a clearing house for jewel bearing users.

In Table I are listed properties of synthetic sapphire and glass bearing materials—two materials commonly used.

While a direct comparison cannot be made from these properties, by correlating Young's modulus and the Knoop value it can be estimated that the glass is about 60 percent as hard as the synthetic sapphire. Indentation tests on the glass have given these values:

Load	Indentation hardness
100 grams	574 Kg/mm²
500 grams	530 Kg/mm²
1,000 grams	507 Kg/mm²

This value will range from 500-600 kg/mm², depending on the conditions of the test.

The coefficient of friction of a hardened steel pivot operating with a sapphire Vee jewel will range from

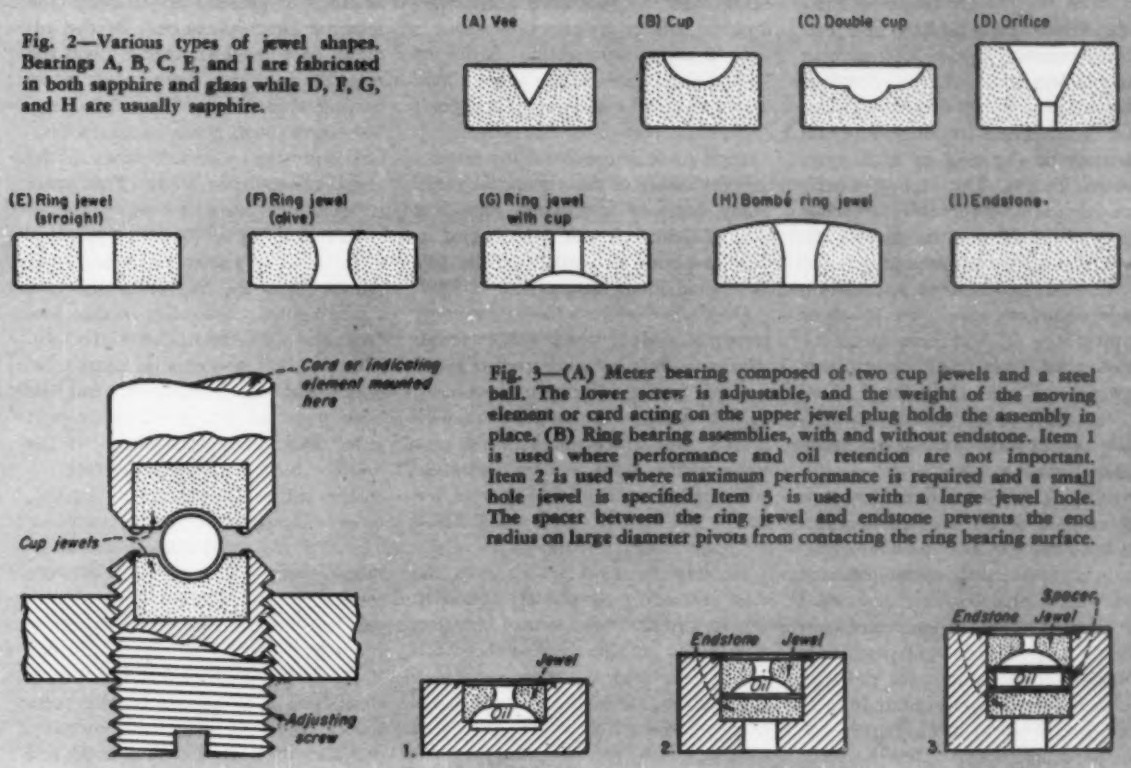


Fig. 2—Various types of jewel shapes. Bearings A, B, C, E, and I are fabricated in both sapphire and glass while D, F, G, and H are usually sapphire.

Fig. 3—(A) Meter bearing composed of two cup jewels and a steel ball. The lower screw is adjustable, and the weight of the moving element or card acting on the upper jewel plug holds the assembly in place. (B) Ring bearing assemblies, with and without endstone. Item 1 is used where performance and oil retention are not important. Item 2 is used where maximum performance is required and a small hole jewel is specified. Item 3 is used with a large jewel hole. The spacer between the ring jewel and endstone prevents the end radius on large diameter pivots from contacting the ring bearing surface.

Components for Quality Equipment

the right material, jewel shape, and mounting arrangement.

0.15 to 0.19, while with a glass Vee jewel an average of 0.18 can be expected.

The selection of the proper jewel material depends on the type of bearing, the weight of the moving element, and the conditions under which the instrument will operate. Under average conditions, a conical pivot and a glass Vee jewel can support a moving element that weighs ¾ gram or less. Where the instruments are not subjected to rough usage, glass bearings have been used with heavier loads. Cushioned jewel assemblies have also helped to increase the usefulness of jewel bearings. In border line applications the instrument should be subjected to tests simulating actual operating conditions to determine whether glass jewels are satisfactory or whether sapphire must be used.

Jewels of other than the Vee shape are usually fabricated from sapphire. While sapphire jewels can replace glass in all applications, it is better to use glass if it satisfies the requirements since the user is assured of a domestic supply, savings in material cost, and better delivery.

There are many standard shapes of jewel bearings as shown in Fig. 2. Other types have been used, but they were designed to solve particular problems.

The shape of the jewel is determined by the type of pivot it must support. This in turn depends on the problems involved in suspending the moving element and on the operating conditions of the instrument. If a conical pivot is used, the bearing will most likely be a Vee jewel, although both single and double cup jewels can be used. It is also possible to use a conical pivot in conjunction with orifice jewels. Cylindrical pivots can be supported by any of the ring jewel designs and combinations. Endstones are used with ring jewels

and a cylindrical pivot.

A. *Vee jewels*—are found in indicating instruments, aircraft and marine instruments, clocks, and parking meters. They are used in conjunction with conical metal pivots but do not allow the exactness in positioning and alignment of the ring or hole jewel discussed below. The unit is usually mounted in an adjustable screw or plug, so that the endplay can be adjusted to suit the assembly. Care must be exercised in assembly so that no damge occurs to either the jewel or the pivot.

Vee jewels are made from both sapphire and hard borosilicate glass, the sapphire jewel being approximately two to three times as expensive as the glass.

B. *Cup jewels*—are found in compass assemblies, hot air motors, and watt-hour meters. For minimum friction in compass applications a conical pivot with a small end radius is used with the cup jewel. In units similar to a watt-hour meter, the cup jewel can be used in combination with ball type pivots, or two cup jewels can support a steel ball between them, Fig. 3(A). The shape of the cup gives the pivot considerable freedom. This freedom of movement must be restricted for proper operation.

Glass cup jewels are used in light compasses, while sapphire jewels are used in large marine units and surveying compasses. Watt-hour meter applications have used sapphire jewels exclusively; although attempts are being made to substitute glass bearings.

C. *Double cup jewels*—have the same general fields of use as the single cup bearing. The addition of the small cup at the bottom of the larger cup restricts pivot sideplay and insures better positioning of the moving element. Many compass installations use this type of jewel. It can be obtained in either sapphire or glass, with the former being more common.

D. *Orifice jewels*—more commonly known as drilled Vee jewels, are usually used for metering the flow of gases or liquids although they can be used as bearings in combination with conical pivots. The jewel consists of a Vee bearing with a close tolerance hole drilled through the apex of the vee to the back of the jewel. These are only made from sapphire.

E. *Ring or hole jewels*—are the most common type and are found in gages, aircraft instruments, electrical measuring instruments, watches, and clocks. They are mated with cylindrical pivots and while they can be fabricated in glass, sapphire is the usual material. This type of bearing is available in a variety of shapes and designs, the simplest of which is the straight hole jewel.

With a straight hole jewel and a cylindrical pivot, the bearing must be accurately aligned if small clearances are to be maintained between the jewel hole and pivot diameter. This combination should only be used where it is possible to maintain the required close tolerances. By the addition of a shoulder on the pivot, the ring bearing can serve as a thrust bearing as well as a journal bearing. The shouldered pivot comes in contact with the polished face of the jewel under thrust loads. This jewel is normally produced in sapphire, however, it can be produced in glass.

F. *Olive hole jewels*—are a further refinement of the ring jewel and give a bearing with a smaller contact surface and, therefore, lower friction. This type has single point contact between the cylindrical pivot and the high point of the jewel. This high point will occur somewhere in the middle third of the hole surface.

The use of an olive hole bearing reduces bearing alignment problems. This type can stand a small amount of misalignment and a closer fit between pivot and hole diameter. The shoulder pivot thrust bearing arrangement can also be used with this type jewel.

G. *Ring jewels with a cup*—are a third type of ring jewel bearing commonly found in the watch industry, but also used in the instrument and gage fields. These jewels can be obtained with either straight or olive holes. The cup serves as an oil reservoir for lubrication of the pivot.

H. *Bombé ring jewels*—are used to obtain low thrust bearing friction. The surface is shaped to allow only point contact with a pivot shoulder,

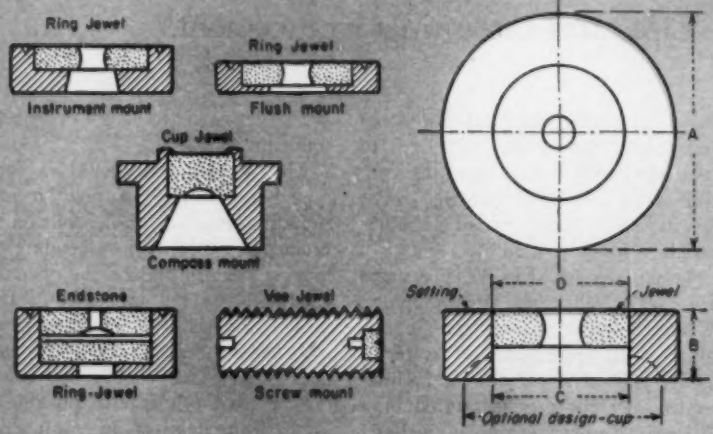


Fig. 4—Types of jewel bearing mounts. These can be obtained assembled as shown from the jewel supplier for use in instruments and meters.

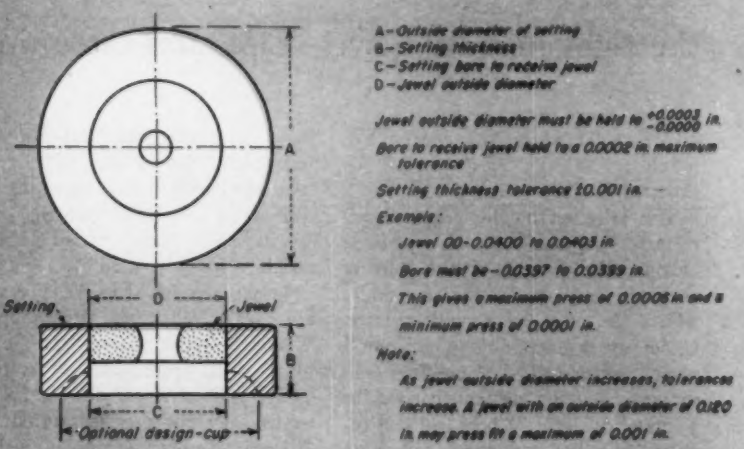

A
Setting
D
Jewel
B
C
Optional design-cup
A—Outside diameter of setting
B—Setting thickness
C—Setting bore to receive jewel
D—Jewel outside diameter
Jewel outside diameter must be held to +0.0003 in. -0.0000
Bore to receive jewel held to a 0.0002 in. maximum tolerance
Setting thickness tolerance ±0.001 in.
Example:
Jewel OD-0.0400 to 0.0403 in.
Bore must be-0.0397 to 0.0399 in.
This gives a maximum press of 0.0006 in. and a minimum press of 0.0001 in.
Note:
As jewel outside diameter increases, tolerances increase. A jewel with an outside diameter of 0.120 in. may press fit a maximum of 0.001 in.

Fig. 5—Tolerance specifications for a friction set ring jewel. In this type of setting the mount material is an important factor. Normally, half-hard commercial brass is used.

compared with the large contact area of the flat top jewel design. In addition, bombé jewels are usually supplied with olive holes for minimum friction both as a journal and thrust bearing, available only in sapphire.

I. *Endstones*—are end thrust bearing plates which are used with one of the various types of ring jewels, Fig. 3(B). They further reduce end thrust friction by applying the thrust load to the endstone via a highly polished radius on the end of the pivot. The most common application of this type of thrust bearing is in watch balance jewel assemblies. Sapphire is the usual material, with some glass endstones being used.

Bearing Mounts

To be of use to the instrument manufacturer, the jewel must be mounted in some type of holder, Fig. 4. Usually this is a brass screw or bushing, although other metals have been used. The jewel is mounted in the holder by one of four methods: friction setting, adhesive setting, spin setting, or cushion setting.

Friction set jewels, Fig. 5, are common in the watch industry. The jewel and setting are assembled by applying pressure and forcing the jewel into the seat. With this method, the outside diameter of the jewel and the hole in the setting must be held to close tolerances.

Under ideal conditions this type of jewel mounting allows rapid assembly. However, damage can occur to the jewels and settings if the jewels have been graded improperly, or if diameters vary. The jewels are subjected to high stresses and strains, and breakage can occur at an excessive rate. This is particularly true when glass jewels are being set using the friction method.

A second method of assembling the jewel and mount is by using some type of adhesive, such as shellac.

In the spinsetting method, the jewel is mounted in a setting and the setting material spun over the beveled edge of the jewel to hold it in place, Fig. 6. This method does not require the closely held diameters that are necessary in friction mounting since each jewel is handled individually, and the jewel seat cut to fit the bearing. No strain is placed on the jewel bearing, and there is no additional stress caused by the setting. However, because of the added operations by the jewel setter this method is slower than the friction method.

When required, the concentricity in friction or spin jewel settings can be held within 0.0001 in. If tolerances are not specified, the concentricity can be expected to be within 0.001 in. Under a special adaptation of the spin setting method it is possible to set an eccentric hole jewel so that the jewel hole and the setting will run true. Thus, both concentricity and diameter tolerances can be low when using this method.

The demand for meters and instruments that will withstand severe conditions of vibration and shock has led to the development of shock mounted jewel bearings. These use springs or other shock absorbing materials.

Spring mounted jewels have been used in many heavy element meters. They show good shock survival characteristics but have limited usefulness because of the high cost of spring mounted assemblies. The spring and mounting operation are difficult to control during assembly and this has reflected in the price.

Another type of shock mount uses a silicone rubber backing for glass Vee jewels, Fig. 7. This assembly is usually mounted in stock meter screws. While it allows the jewel freedom of movement within the mount, it also controls this movement so that there is no chance of loose fitting assemblies. The silicone backing is varied in thickness to suit different conditions of instrument operation.

Cushioned jewel assemblies are relatively new and extensive performance data is not yet available. Tests of glass Vee bearings, mounted conventionally and cushion mounted, are currently being run under government auspices. The results show that the instruments with cushioned jewels are subject to less bearing and moving

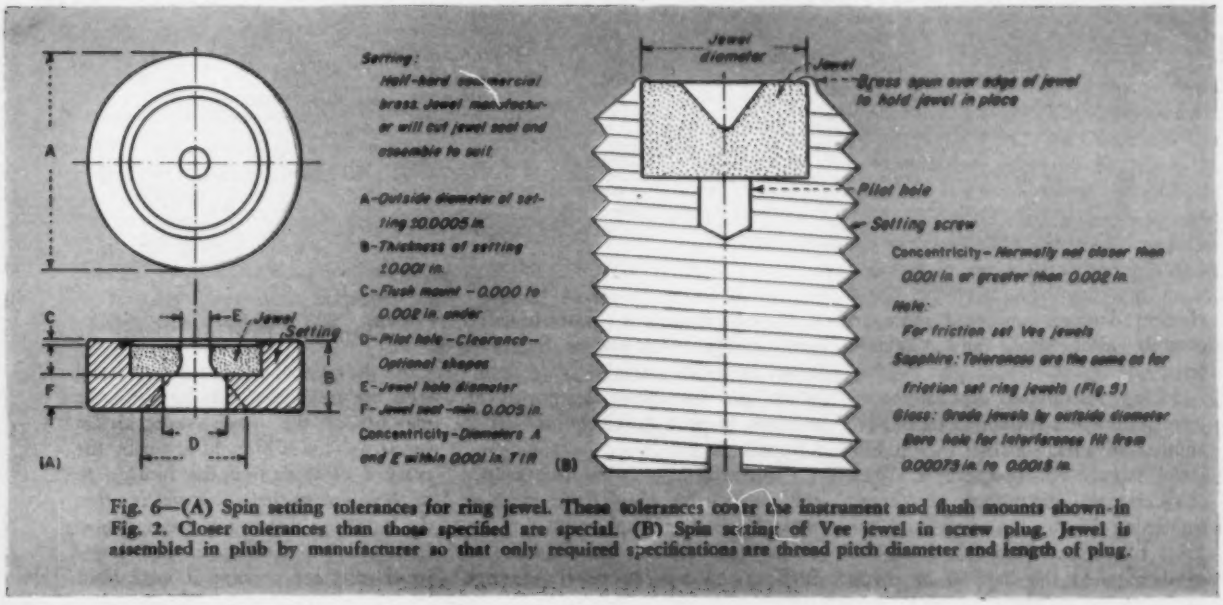

A
C
F
B
D
E
Jewel
Setting
(A)
Setting:
Half-hard commercial brass. Jewel manufacturer will cut jewel seat and assemble to suit
A-Outside diameter of setting ±0.0005 in.
B-Thickness of setting ±.001 in.
C-Flush mount - 0.000 to 0.002 in. under
D-Pilot hole-Clearance-Optional shapes
E-Jewel hole diameter
F-Jewel seat-min. 0.005 in.
Concentricity-Diameters A and E within 0.001 in. TIR
Jewel diameter
Jewel
Brass spun over edge of jewel to hold jewel in place
Pilot hole
Setting screw
Concentricity-Normally not closer than 0.001 in. or greater than 0.002 in.
Note:
For friction set Vee jewels
Sapphire: Tolerances are the same as for friction set ring jewels (Fig. 5)
Glass: Grade jewels by outside diameter
Bore hole for interference fit from 0.00073 in. to 0.0018 in.
(B)

Fig. 6—(A) Spin setting tolerances for ring jewel. These tolerances cover the instrument and flush mounts shown in Fig. 2. Closer tolerances than those specified are special. (B) Spin setting of Vee jewel in screw plug. Jewel is assembled in plub by manufacturer so that only required specifications are thread pitch diameter and length of plug.

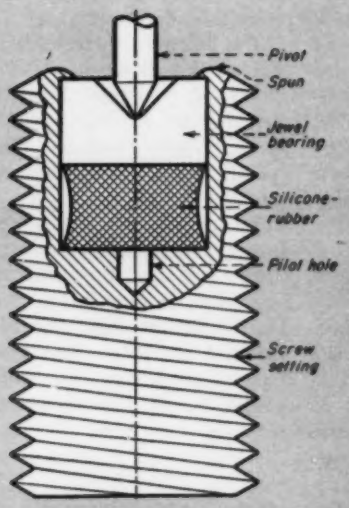


Fig. 7—Vee jewel in silicone rubber shock mount assembly. Rubber is varied in thickness, durometer value and pressure to suit requirements. Units similar to this are available in a variety of thread sizes.

Fig. 8—Semi-automatic arrangement for spin setting jewels. Operations include boring the hole to receive the jewel, placing jewel in hole and spinning brass over edge of jewel.

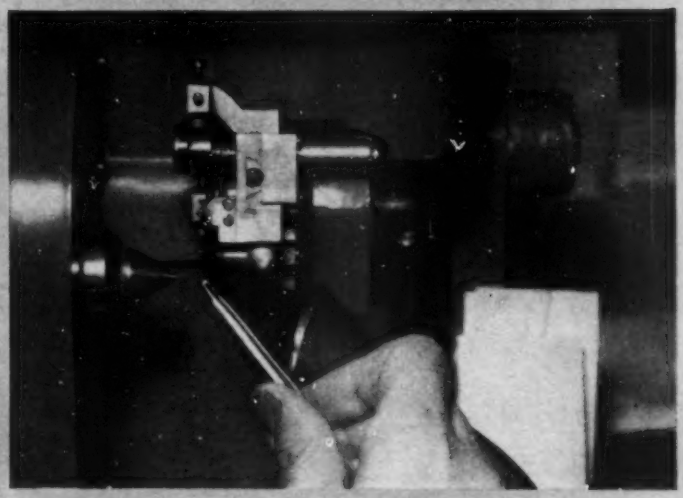


Table II—Standard Glass Vee Jewels

O.D., in.	Thickness, in.	Radius, in.	Angle, deg.	Depth of Vee or cup, in.	Contour
0.040	0.030 G	0.003-0.004	80	0.010-0.015	V
0.050	0.045-0.070	0.003-0.004	70-90	0.012-0.018	V
	0.035 G	0.003-0.004	80	0.012-0.018	V
0.055	0.035 G	0.003-0.004	80	0.015-0.020	V
	0.035 G	0.005-0.006	90	0.012-0.015	V
0.060	0.040 G	0.001-0.002	80	0.015-0.018	V
	0.040 G	0.003-0.004	80	0.012-0.018	V
0.070	0.040 G	0.003-0.004	80	0.012-0.018	V
	0.040 G	0.005-0.006	80	0.012-0.018	V
0.076	0.055-0.090	0.003-0.004	70-90	0.010-0.016	V
	0.040 G	0.003-0.004	80	0.012-0.018	V
0.080	0.040 G	0.006-0.008	90	0.015-0.025	V
0.105	0.055 G	0.005-0.006	100	0.020-0.025	V
	0.055 G	0.020	120	0.020-0.025	Cup (Single or Double)

Normal variance in outside diameter is 0.003 in., in angle 10 deg., in thickness the jewels can be obtained either ground (those items noted by the G) to a uniform thickness, or unground with a thickness variance of about 0.025-0.035 inches. The size of the mounting screw or plug depends on the root diameter of the thread. There should be a side wall thickness of at least 0.0075 in. for a proper assembly.

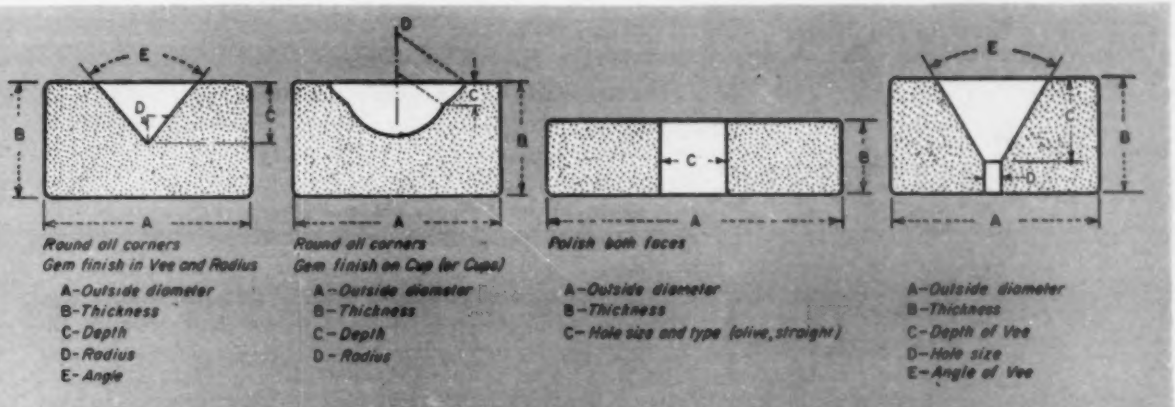
element damage, and read more accurately after shock and vibration tests.

Some instrument manufacturers have found that cushioned units have another advantage in that they reduce jewel damage during assembly. With conventional mountings, excessive tightening of the bearing causes the pivot to bottom with the possibility of damage to the bearing or pivot. Cushioned units give a factor of safety and do away with one of the headaches in meter assembly by reducing waste and instrument teardowns attributed to poor judgment in bearing adjustment.

Cushioned assemblies have helped the inexpensive glass jewel compete with the costlier sapphire bearing, reducing manufacturers' dependence on foreign sources for jewel bearings.

Standard Bearing Sizes

At the present time very few jewel sizes are considered standard and the majority of the jewels supplied are specials. This is brought about by the practice of designing the bearing to fit the pivot so that the jewel is often the last thing that is given dimensions. Increased standardization and lower jewel costs are possible if instrument



	Vee	Cup	Double cup	Orifice	Ring jewel (straight)	Ring jewel (olive)	Ring jewel with cup	Bombé ring jewel	Endstone
Outside diameter									
Thickness									
Depth of Vee or Cup									
Radius at apex of Vee									
Hole size									
Angle of Vee									
Type hole									
Cup size									
Polish	Vee area	Cup	Cups	Vee hole	Faces hole	Faces hole	Faces hole	Faces hole	Faces
Material	Glass	Glass	Glass	Sapphire	Glass	Sapphire	Sapphire	Sapphire	Glass
	Sapphire	Sapphire	Sapphire		Sapphire				Sapphire

Fig. 9—Specifications required by jewel manufacturer. The diagrams show the location of the dimensions on four shapes. In ordering jewels listed in chart all information should be supplied except that covered by crossed boxes.

designers will determine what stock jewels are available before freezing the dimensions of the other instrument components. In applications where special jewel sizes are required, the information shown in Fig. 9 should be given to the jewel supplier.

Certain glass and sapphire Vee jewels are available from stock as listed in Table II. A chart covering ring jewel standard sizes would accomplish little since stock sizes for one supplier may be special with others.

There is more consistency in the size of jewel mountings than there is in the size of the jewels themselves. Most manufacturers of electrical instruments for testing and indicating purposes use jewel screws within the following range of sizes: #1-72, #2-80, #3-56, #3-72, #4-80, #4-90 and 0.100x100. The last named size is most common.

Jewel Quality

Jewel bearings are inspected with binocular microscopes that range in magnification from 25 to 40 power. Nothing higher than 45 power should be used for production work. The critical areas on the jewels are those that come in contact with the pivots and those that could cause indication errors in meters.

In a Vee jewel, either glass or sapphire, the critical area is the lower third of the Vee, approaching the radius and the radius itself. Both of these areas should be well polished and free from defects, either on or below the surface. Primary defects are bubbles near the surface in glass jewels, and imperfections in sapphire manufacture. Cup jewels of all types must be well polished and free from imperfections in the cup area.

The critical spots on ring jewels lie within the hole which should be highly polished and free from defects. The entrance to the hole should be free from chips or indications of possible chips caused by poor sapphire. Jewels in general should not be rejected for defects in noncritical areas where slight imperfections do not interfere with instrument operation.

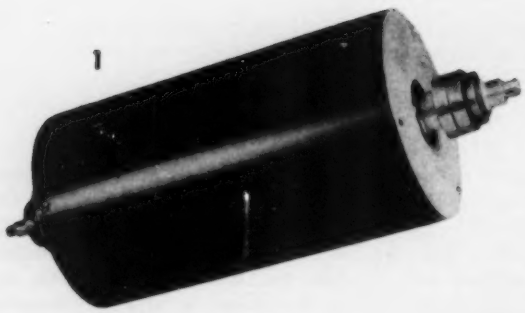
Magnetic Drum Storage Devices

ROBERT L. PERKINS
Mechanical Engineer
Engineering Research Associates
Division of Remington Rand Inc.

A magnetic storage drum is an intermediate speed memory device, capable of repetition rates in excess of the fastest relay systems but not as fast as electro-storage devices or acoustical delay lines. Since the development of drum storage devices resulted from the need for such a component in large scale digital computing machines, most applications to date have been in this type equipment. However, future demands are seen for these devices in the fields of automatic filing equipment, automatic sorting equipment, material processing control applications, and other places where large scale memories are required.

While the magnetic drum type of storage does not have any one feature in which it excels all other memory devices, it is unique in that it combines the following advantages in one unit.

- **Nonvolatility—Information when once stored is not lost with the passage of time or the interruption of power.**
- **Alterability—The storage medium is reusable and stored information can be changed either by erasure or application of another information unit.**
- **Low access time—The time required to search for and read out specific pieces of information is short.**
- **High storage density—Currently 1280 binary digits can be stored per square inch of storage medium surface. A density of 2,200 can be achieved in certain systems that permit utilization of a *nonreturn-to-zero* recording method.**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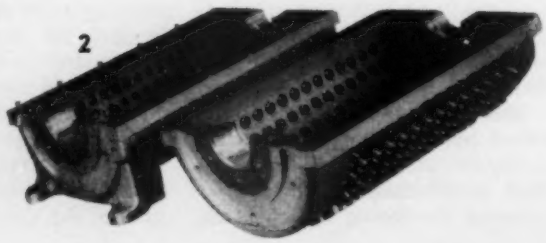
1. Like most other types of storage devices, the magnetic drum is a two state medium capable of storing intelligence as two levels of magnetization of an area on the surface of the drum. All information must therefore be reduced to a binary code and is fed into the drum writing heads as a series of on-off voltage pulses. The heart of the magnetic storage system is the drum assembly. Basically, it consists of a precision built cylinder rotating about its axis and coated with a magnetic material similar to that used on magnetic recording tapes. Drum surface speeds of about 1,600 inches per second are normal for typical units.

2. The cast drum is either shrunk or taper fitted and locked to its steel shaft. Larger diameter drums use aluminum shafts with press fitted steel end caps for bearing seats. Bearing lubrication is of the ball center oil level type. Access to the storage medium is through magnetic recording heads disposed along the length of the drum so that each head covers a narrow band or track around the periphery of the cylinder. Mounting inserts for these heads are pressed and staked into a cast aluminum case or shroud. This radial mounting technique permits the total enclosure of the rotating drum within the case with the rotor bearings supported in pillow blocks machined in the case.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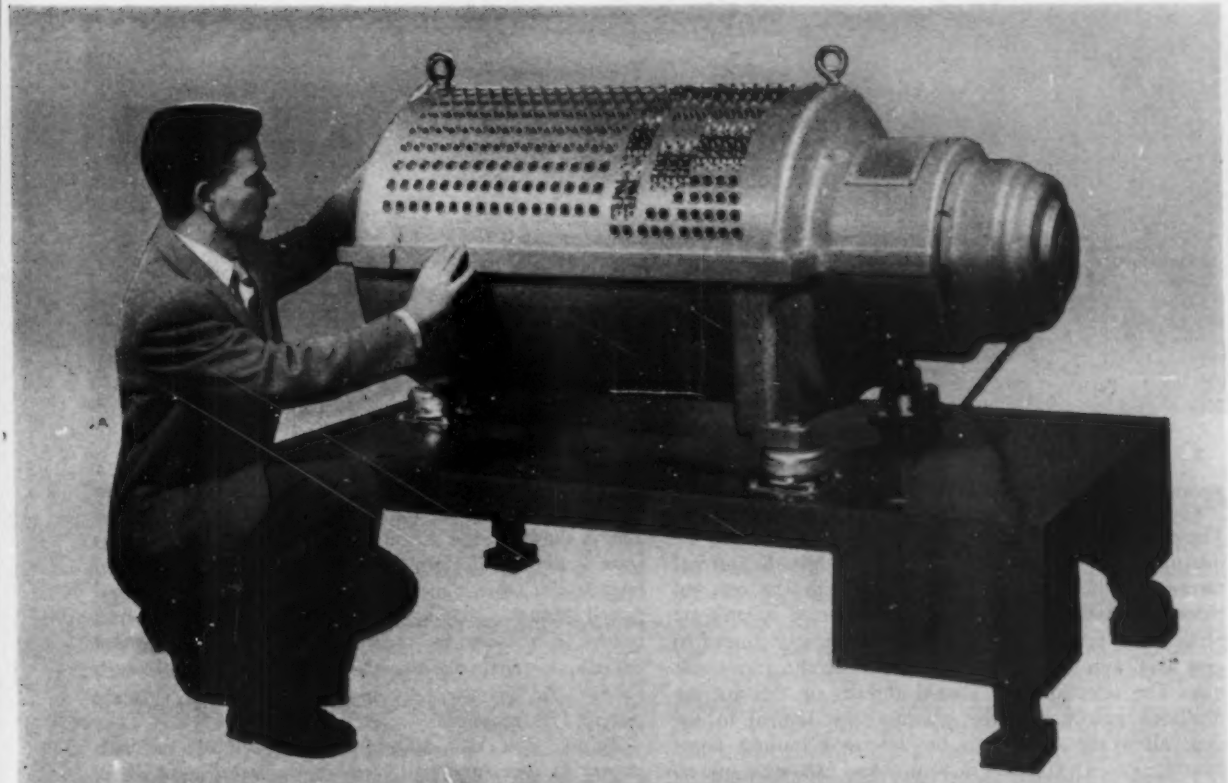
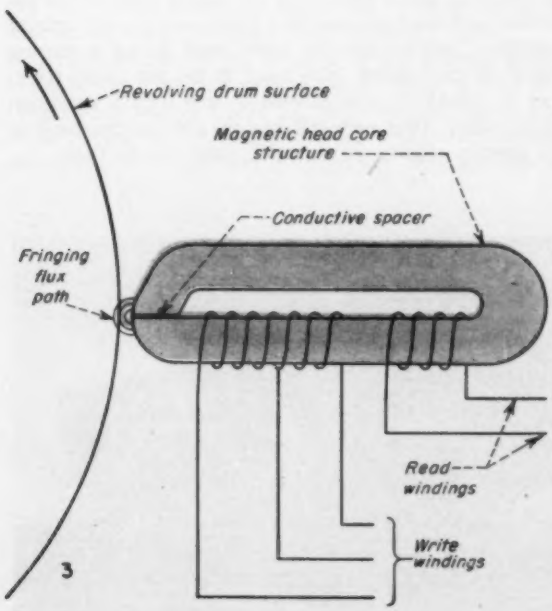


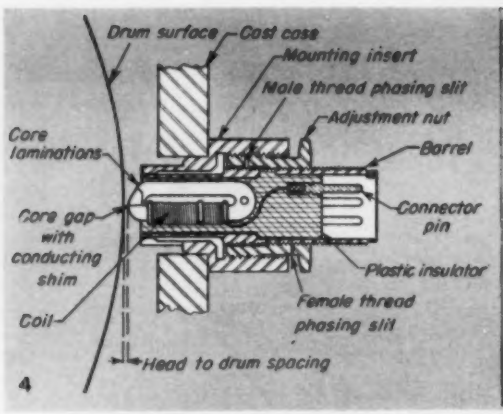
This recording surface stores nearly 4,500,000 binary digits when the most efficient recording mode can be utilized. In the more usual case, it has been used to store 2,500,000 binary digits.

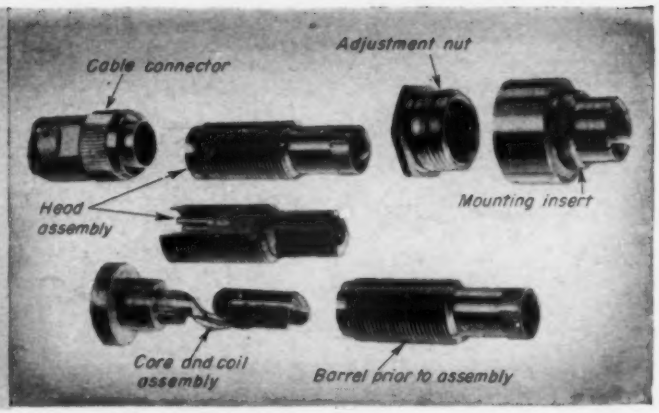


3. The magnetic heads are composed of a core structure linked with both reading and writing coils. The write winding is center tapped so that the direction of flux through the core can be selected by the choice of end taps. The head is mounted and adjusted radially to bring the small core gap close to the periphery of the coated cylinder. Flux behavior around the gap causes fringing which permanently magnetizes an elemental area on the drum surface. The presence of a highly conductive material in the magnetic gap of the core structure improves the ratio of fringing to total flux for short duration current pulses in the order of one to two microseconds. During the reading operation the written cell is moved past the magnetic gap, momentarily changing the flux state through the core. This change of flux is sensed or read by the reading winding and amplified.

The written mark can be read as often as desired and will not decay with time or use unless influenced by strong magnetic fields (erased). One distinction should be pointed out; it is possible to write on the drum surface with the drum at rest, but there must be relative motion between the head and the surface for reading.

(continued on next page)



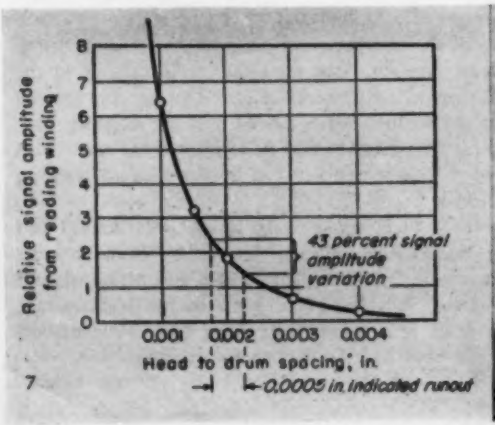


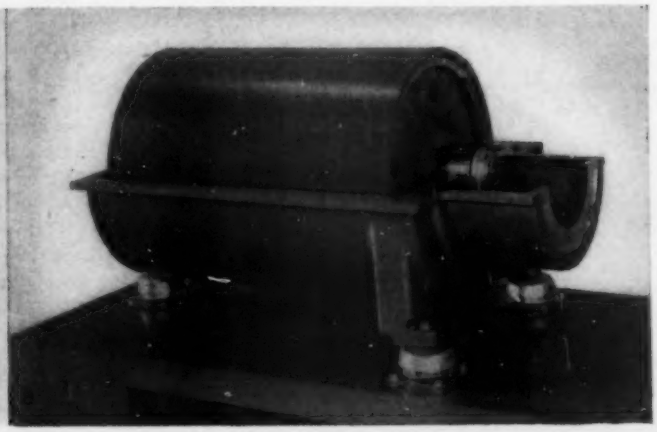
4. Radial adjustment of the head to drum spacing is obtained by means of a differential thread system. The external threads of the adjustment nut mate with the internal threads of the mounting insert, while the internal threads of the adjustment nut mate with the external threads of the barrel. Since these two thread systems are of different pitch, they behave as a differential thread to give axial adjustment upon movement of the adjustment nut. The internal and external threads of the nut are displaced axially, and the phasing slits, normal to the axis, allow the threads to be deformed causing phase interference. This results in zero thread clearance and no lock nuts are required.

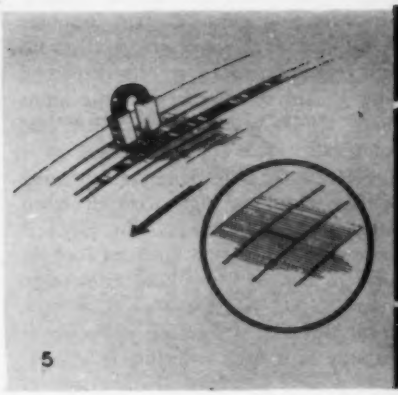
5. The imaginary condition of the drum surface is shown as having a multiplicity of peripheral tracks. Each track is divided into rectangular cells. Within the boundaries of these cells a smaller area is magnetized in one peripheral direction to represent a stored binary "1" or in the opposite direction to represent a binary "0". In the diagram, cell polarity is indicated by either a white or black marking. Current drums utilize densities of 80 cells to the linear inch around a track and 16 tracks per inch along the axis. This represents 1280 binary digits per square inch of drum surface. At peripheral speeds of 1,600 inches per second each head can read 128,000 binary digits per second.

6. As stated previously, information is obtained from this device in the form of a series of voltage pulses. This is shown by the oscilloscope patterns where the upper trace is the signal from the reading head and the lower trace is the same signal after it has been amplified and passed through a shaping circuit. This is a two level return system since there are two levels of magnetization and under a no-signal condition the cells return to a "0" level. Pattern (A) represents the binary number "1,0,1," while pattern (B) represents "1,1,1".

To give each cell a definite position physically and with respect to time, one track and its associated head is reserved for clock reference. This track is written with a continuous succession of marks of like polarity around the drum. The vertical lines on the oscilloscope pattern show the position of the head signal relative to the timing signal. The line spacing represents 7.8 microseconds in time, or 0.0125 in. on the drum periphery. Another track is usually reserved for a single index mark to give a starting point to the clock pulses read from the timing track. With the timing track head reading clock pulses continuously into an electronic counter and the index head giving a starting signal to the counter, each head in the remaining tracks can be caused to write or read in step with a significant clock pulse. Thus each cell has an address composed of its position relative to the index mark and its track.







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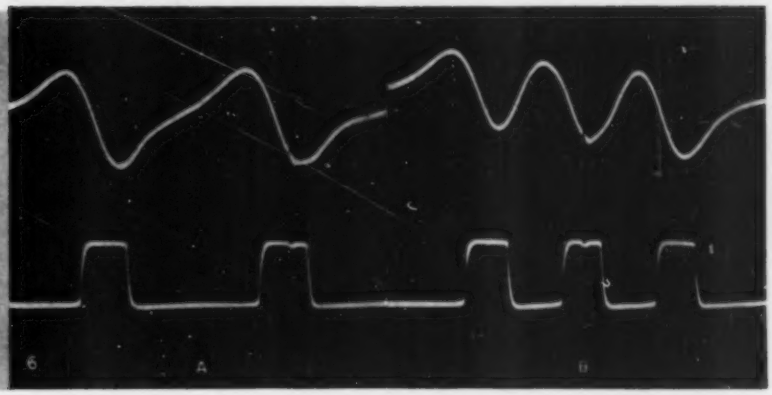


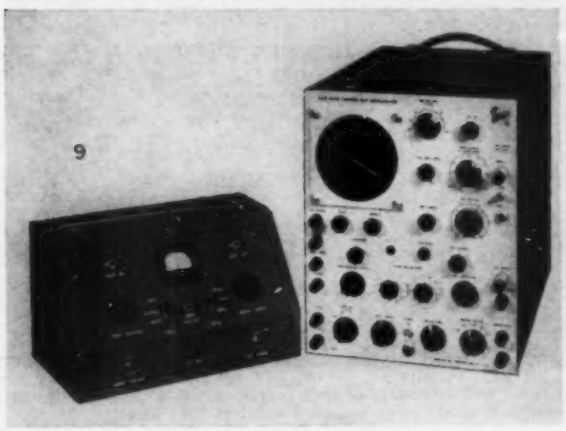
6 A B

7. To maintain uniform signals from the drum (uniform head to drum spacing) throughout a complete revolution, close limits are imposed on the precision of the peripheral surface. Total indicator runouts of less than 0.0001 in. are common; however, anything less than 0.0002 in. is tolerated. The tolerances that are necessary to maintain the small head to drum spacing of 0.002 in. require zero clearance fits of all component parts of the assembly from the drum surface throughout the structure to the head mounting. A typical magnetic head performance characteristic of signal amplitude versus head-to-drum spacing is shown by the curve. At 0.002 in. spacing, a runout of 0.0005 in. causes a signal variation of 43 percent. Thus, if the electronic network is to operate within reasonable limits, the runout must be kept to a minimum.

8. To keep the runout within allowable limits, the outside diameter of the drum is finish machined with the shaft rotating in its own bearings. This design uses a pair of preloaded angular contact ball bearings mounted DB at each end of the shaft. Final machining, coating, and balancing are done in the bearings so that bearing runout is not reflected in drum surface runout. Drum spacing and concentricity tolerances also introduce the problem of material stability and thermal expansion behavior of constituent parts. This problem is aggravated with increase in physical size. For example, a 0.002 in. spacing represents one part in 2,125 for an 8.5 in. dia. drum; but for a 22 in. dia. drum it represents one part in 5,500. Aluminum has been found to be the most satisfactory prime material for the drum and case.

9. Since the case halves and drum are assembled before the mounting inserts for the magnetic heads are pressed and staked in the case, the drum spacing adjustment must be made blind without the use of feeler gages. This is accomplished with an electronic head setter and an oscilloscope. The head setter alternately writes and reads a single random mark, and allows the head to be adjusted for optimum signal strength. The oscilloscope is used to read the relative signal amplitudes.

10. In the smaller sizes, the spindle is direct driven by a single or three phase conventional induction motor through a flexible coupling. Larger types are driven by axial air gap motors through a centrifugal clutch. The three point mounting prevents case distortions resulting from uneven mounting surfaces. The rotating parts are completely enclosed with the exception of the manual turn knob on the end opposite the motor. This unit has a drum 8½ in. in diameter and 15 in. long with inserts for 218 heads to store about 465,000 binary digits.



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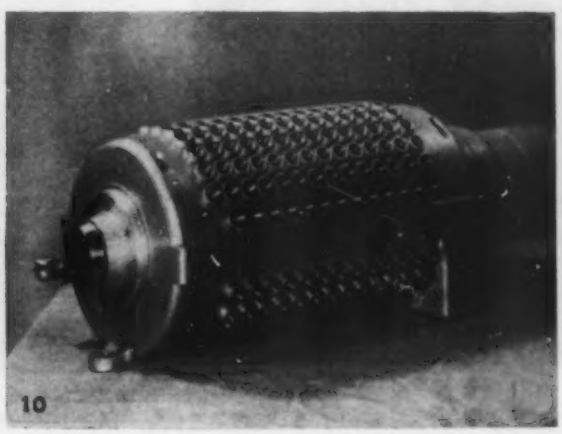


10

Curved Jaw Stretch Forming

J. S. CORRAL
North American Aviation Incorporated

THE LATEST ADVANCE in stretch forming is the replacement of straight jaws with a new flexible jaw arrangement on Hufford presses. The jaw assembly is curvable to a minimum concave or convex radius of 17 in. at 180 deg right or left, compound and S curves and almost any intermediate shape between these extremes. The gripper unit can also be oscillated 15 deg or rotated 20 deg as required, Fig. 1 (left), for stretching shapes with compound and reentrant contours.

The advantage of curved jaws is that they allow substantial reductions in blank sheet sizes, which constitute savings in material ranging as high as 35 percent. This factor assumes even greater proportions in terms of dollars when processing expensive materials like titanium.

In addition to material savings, there has been a widening of the range of materials applicable to stretch forming. Now included are high strength aluminum alloys, such as 75ST6 in the full hard temper, heretofore considered impossible to stretch form because of limited stretchability, low elongation and narrow forming range (spread between yield and ultimate strength).

With the jaw development only 5 percent of the total parts currently being produced are stretched in the W temper. The remaining 95 percent are formed using 75ST6 as received from the mills, thus eliminating preform heat treatments, artificial aging operations, and at the same time, effecting reductions in manufacturing time.

Now that the process has been improved to allow closer control in forming, more consideration is being given to the increase in properties resulting from stretching, particularly when forming parts of more complex configuration that call for high strength steels with undesirable stretching characteristics in the hardened temper. By stretching ¼ hard stainless beyond the limits required for forming, tensile values higher than the minimum for ½ hard stainless steel can be obtained.

Another example is 17-7 P.H., a precipitation hardening stainless steel alloy that develops high strength when processed by a two stage heat treatment. In the first stage, the metal is heated 1½ hr at 1,400 F. After cooling, it is again heated for 30 min at 950 F and allowed to cool.

After heat treatment the stretch forming operation is extremely difficult because of a high reduction in elongation. The alloy does possess a unique characteristic in that stretching in the annealed temper produces the same effect as the 1400 F heat treatment. Thus, controlled stretching followed by low-temperature heat treatment develops properties in 17-7 P.H. equal to those obtained by the two-stage heat treatment.

Using this procedure, the forming operation becomes relatively simple and the problems of distortion and removal of scale caused by the high-temperature heat treatment are minimized. The excellent stretching qualities of stainless steels in the annealed temper coupled with the efficiency of the grippers facilitate low cost production of deeply contoured shapes such as that shown in Fig. 1 (right) below.

The curved grippers are also the solution to a problem previously encountered with straight jaws. The problem was the formation of longitudinal buckles in the skins with shallow contours caused by the natural tendency of sheet to contract laterally when forming pressures are applied. With curved jaws, buckling is avoided by promoting closer adherence of the sheet to the form block. This feature is particularly useful when stretch forming skins with milled cavities in local areas.

With the advent of stronger metals and the increasing complexity of design configurations, the new jaw arrangement has refined the stretching process to the immediate advantage of design and production.

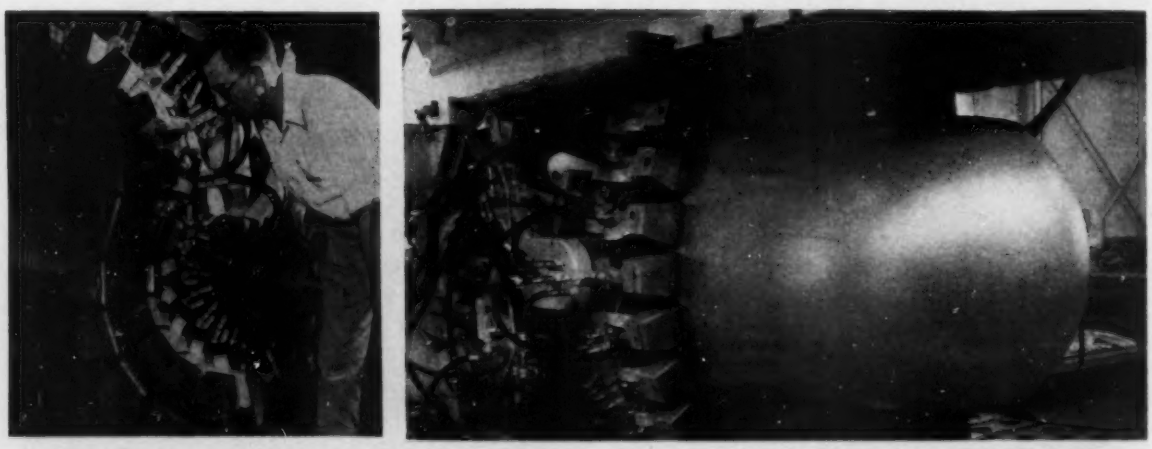


Fig. 1—(Left) Adjustable curved jaws facilitate stretch forming of compound contours; (right) deeply contoured shapes are produced with relative ease due to efficiency of grippers and excellent stretching qualities of annealed stainless steel sheet.

TENSILE TESTING

At High And Low Temperatures

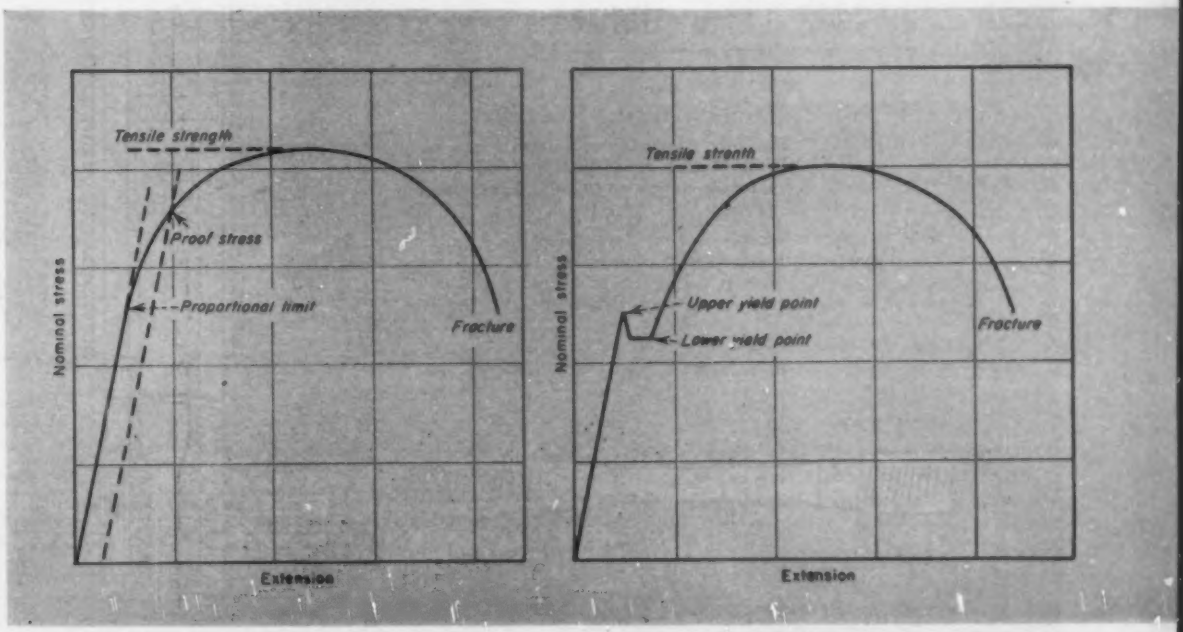


Fig. 1—A typical stress-strain curve, showing the gradual onset of plastic flow, is the best way of showing the results of a tensile test. Fig. 2—A stress-strain curve of iron and low alloy steels, showing the sudden yielding into the plastic stage, typical of a mild steel at normal temperatures.

K. W. MITCHELL
Fulmer Research Institute, England

ALTHOUGH the tensile test is usually used for evaluating the load-carrying capacity of a material, this is not, by any means, its only function. The measurement of ductility by elongation and reduction of area is also of importance when it is necessary to assess the potentialities of a material for wire-drawing, pressing or forming operations.

A stress-strain curve, shown diagrammatically in Fig. 1, is the means by which the results of a tensile test are best expressed. The curve is characteristic for most materials, and shows a gradual onset of plastic flow. Iron and low alloy steels, however, behave differently and exhibit an abrupt onset of plasticity as in Fig. 2.

The quantities measured are the proportional limit, the proof stress or yield stress, (i.e. the stress required for a permanent extension of a specified amount, usually 0.1 or 0.2 percent of the gage length), the ultimate tensile stress, the percentage elongation on a specified length of the specimen, and the percentage reduction of area at fracture. Care must be exercised in the preparation of specimens in soft materials to avoid working of the surface layers, which would increase the hardness of the surface layers and the strength of the specimen, and result in compressive stresses in this layer. It has been shown by Stickley and Bogardus[1] that machining by rough cuts can increase the yield stress of super-purity aluminum by 100 percent, the ultimate tensile strength also being increased but not to such a large extent.

TABLE I

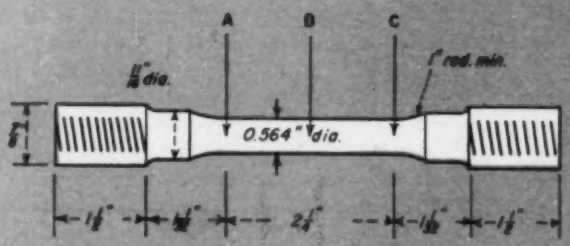
Heating medium	Temperature range, F
Distilled water	Up to 212
Paraffin	Up to 390
Mineral oil	Up to 660

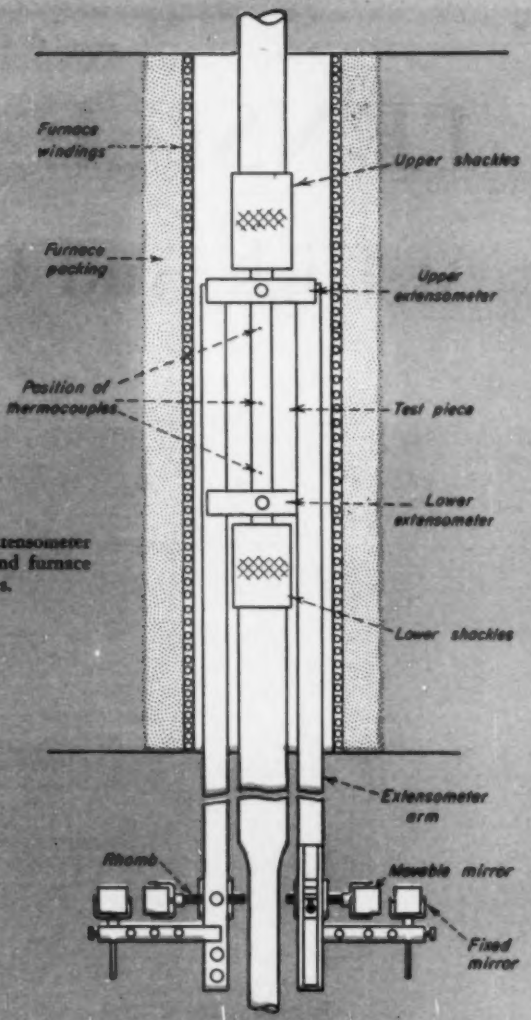
TABLE II

Sensitivity, in./in.	Proportional limit, T/in.²
0.000002	10.0
0.00001	11.2
0.00002	12.4
0.0001	16.8

Fig. 4—An assembly of a mirror type extensometer of the Martens type, the test specimen, and furnace for tensile testing at elevated temperatures.

Fig. 3—A test piece commonly used for elevated temperature testing. Thermocouples are attached at points A, B, and C. All tool marks should be removed, and the test piece given a good surface finish.





Testing at Elevated Temperatures

The short-time tensile test, as distinct from creep testing, is commonly used for the determination of the mechanical properties at elevated temperatures to give some indication of the forging and hot pressing qualities of a material. It is of particular value in revealing the embrittlement of a material which sometimes occurs at high temperatures and is usually termed "hot-shortness."

At elevated temperatures the stress-strain curve for a material is generally of a similar nature to that at atmospheric temperature, except that in the case of iron and low alloy steels the yield point illustrated in Fig. 2, disappears above the "blue-brittle" temperature of 500 F. To have uniformity in a testing procedure and consequently a comparability of results, specifications are now laid down which describe the type of specimen, preparation, the control and uniformity of temperature, and the procedure to be adopted when making the test.

The construction of equipment for hot tensile testing varies widely, although it is usual for the apparatus to be used with standard tensile testing machines of either the lever or hydraulic types. The auxiliary equipment consists of a heating furnace that surrounds the test specimen with some form of extensometer used for measuring the elongation under load.

The heating furnace may be one of several types. At relatively low temperatures, a liquid bath may sometimes be effectively used, but it is essential that the heating medium should not attack the material under test. Suitable liquids, given in Table I, are heated by an electric immersion heater, and stirrers must be installed to circulate the liquid and ensure a uniform temperature along the test specimen gage length.

The most common method of heating the specimen to the required tem-

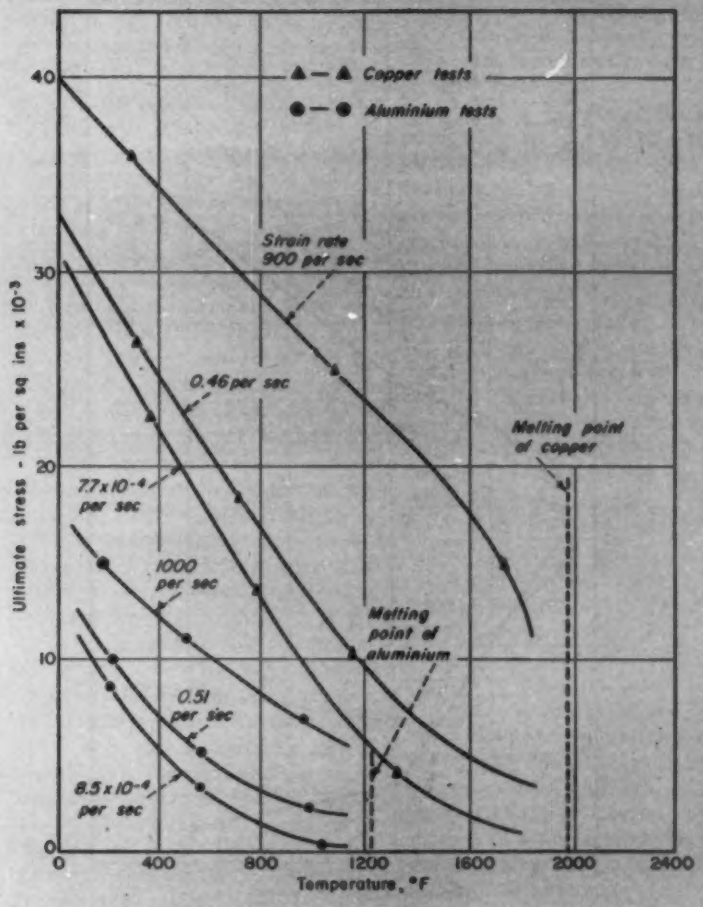


Fig. 5—The effect of the temperature and strain rate on the ultimate tensile stress of pure copper and pure aluminum.[6]

perature is by surrounding it with a resistance furnace. Other methods, such as high frequency induction heating and the direct passage of electric current through the specimen, have been used, the latter having the advantage that the specimen is exposed and accessible for extension readings to be made with comparative ease, although large electrical currents are required.

In general, however, the method most often used throughout the entire range of temperature is an electric resistance wound tube furnace surrounding the specimen. The heat losses are not uniform along the test specimen, and compensation has to be made for this in the design of the furnace. This may be achieved by a suitable spacing of the windings, more turns being needed near the ends of the furnace if the winding is continuous, or more commonly by the use of separate zones of wiring, each with independent regulation.

The temperature of the specimen is measured by thermocouples fastened to the specimen. Three such couples are used, the positions being as indicated in Fig. 3, which shows a type of specimen commonly used for elevated temperature tensile testing. With materials which become notch sensitive at elevated temperatures, care must be taken to ensure that stress concentration factor for a thread is less than the ratio of area at the base of the thread and at the gage diameter, or failure is likely to occur in the threaded portion of the specimen. One other precaution worthy of mention in connection with temperature measurement, is that, due to the difference in emissivity between specimen and couple, the hot junction of the couple must be well covered to prevent direct radiation from furnace walls falling on the couple tip, thus giving a false temperature reading.

Various methods for the measurement of the extension of the gage length are used, but it is usual for the extension to be transferred by some mechanical means to outside the furnace where it may be measured mechanically or optically. To measure strains to an accuracy of ± 1 percent, it is necessary to use an extensometer with a strain sensitivity of at least 10^{-4} in./inch. Even higher precision is needed if a study is being made of small variations in elastic constants, and difficulty is often experienced in the transference of the strain to the measuring point without introducing an error. Generally, the most suitable method is that in which the extension of the gage portion of the specimen is made to rotate a mirror. Such a method now widely used employs the mirror extensometer principle of Martens. The sensitivity of this type of instrument is very high, being of the order of 10^{-6} inches/inch.

One example of the need to quote sensitivity of the extensometer when reporting results is in the measurement of the proportional limit, which, other conditions being equal, depends on the accuracy of the extensometer. Tapsell[2] gives the figures for a steel tested at 752 F in Table II.

For general engineering use, the proportional limit has little significance by itself, and the strain sensitivity should be quoted when such measurements are reported. It is usual, instead, to quote a yield stress that is independent of sensitivity, except under conditions of temperature and stress in which creep can occur when the time taken in applying incremental loading and measuring the extension becomes of importance.

In Fig. 4 is a typical test apparatus for elevated temperature testing which incorporates the furnace, test specimen

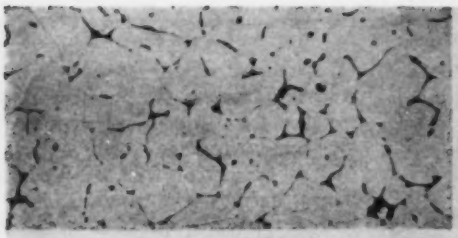


Fig. 6—A microstructure (X150) of a chill cast aluminum alloy of 15 percent tin. Boundary films of the aluminum-tin eutectic are weaker than the aluminum matrix.

Fig. 7—A microstructure (X250) of aluminum with 1.6 percent copper and 20 percent tin which has been cold worked from 2½ in. diameter to ½ in. square.

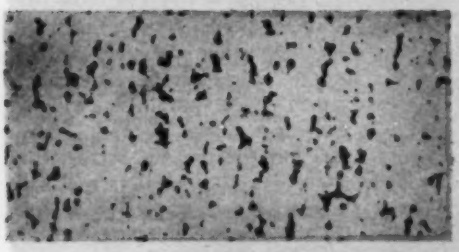


Fig. 8—A microstructure (X250) of the worked structure in Fig. 7 after it has been annealed for one hour at 660 F so that recrystallization occurs. In this condition there are no weak intergranular films.

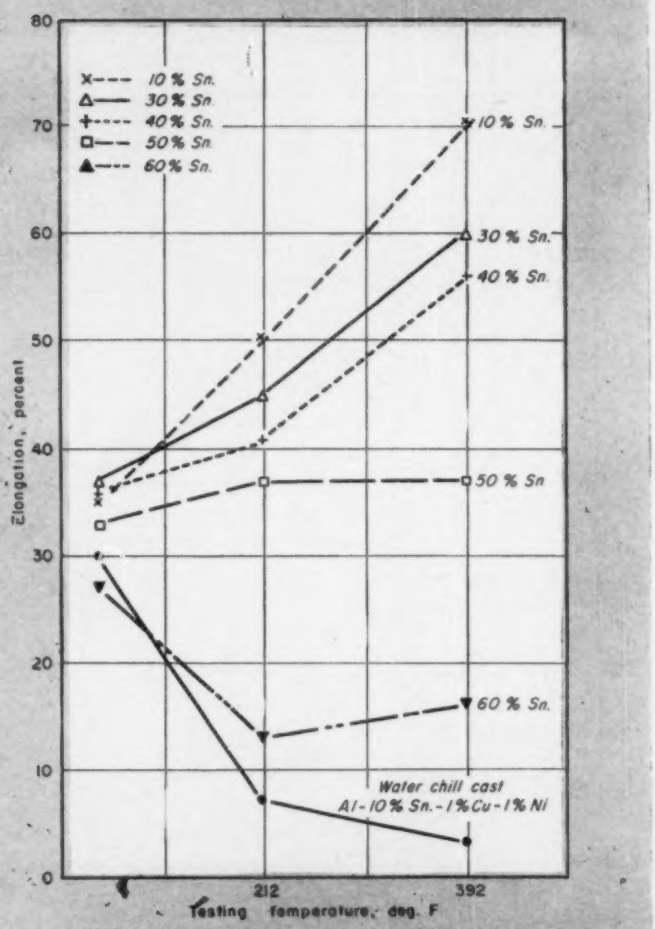


Fig. 9—Elongation values at different temperatures for alloys with an aluminum-copper ratio of 98:2, and containing various amounts of tin, cold forged from 2½ in. diameter to ½ in. square, and annealed for one hour at 660 F. Values are also included for a water chill cast aluminum 10 percent tin alloy.

and mirror type extensometer of the Martens type.

The high temperature strength of a metal is dependent not only on the temperature, but also on the time, and therefore on the rate of straining. It is now usual to specify the straining rate and for a comparative series of tests to have this variable controlled. Knowledge of the testing speed is of major importance, since the amount of strain hardening varies with the strain rate, besides being of increasing importance in the measurement of final elongation. A constant strain rate of 0.25 in./minute for a 0.564 in. gage diameter specimen is often adopted in tests in Britain. Fig. 5[3] shows the effect of temperature and strain rate on the ultimate tensile stress of copper and aluminum.

Two examples illustrate the value of tensile tests at elevated temperatures in metallurgical practice. The first relates to the development of aluminum-tin alloys as anti-friction bearings and has been described by Hardy, Liddiard, Higgs and Cuthbertson.[4] Aluminum-tin alloys, in the chill cast condition consists of two phases: the aluminum matrix phase, and a degenerate aluminum-tin eutectic which is distributed as thin films around the grain boundaries.

The typical microstructure of a chill cast alloy containing 15 percent tin is shown in Fig. 6. The boundary films of aluminum-tin eutectic are much weaker than the aluminum matrix and their strength decreases markedly with increasing temperature, the melting point of the eutectic being 442 F. For this reason the elongation, which is determined by the strength of these intergranular films, decreases rapidly with rising temperature and falls to zero at the melting point of the eutectic. This is shown in Fig. 9, by the values for the chill cast aluminum—10 percent tin alloy containing 1 percent of nickel and copper.

If, however, the alloys are cold forged, the eutectic films are drawn out in the direction of working as shown in Fig. 7. If this worked structure is annealed at 660 F so that recrystallization occurs, the interfacial tension relationship between aluminum-tin and aluminum-aluminum at the annealing temperature is such that the tin is drawn up into isolated pools at grain corners where they remain on cooling, as illustrated in Fig. 8. In this condition there are no weak intergranular films, and the ductility at high temperatures shows the normal temperature dependence, increasing and not decreasing with increasing temperature. This is illustrated in Fig. 9 for alloys with up to 40 percent tin. In the worked and annealed conditions, the elongation decreases with increasing temperature only for alloys with tin contents of 50 percent and above.

A further example of the value of tensile tests at elevated temperatures is in assessing the suitability of a material to be worked at a temperature appreciably above its recrystallization temperature. For this, it is required to determine: (a) the temperature range over which a metal or alloy is ductile and; (b) its resistance to deformation at temperatures within that range. These values will give some indication of workability, since a low tensile strength and high ductility over a temperature range suggests ease in working from power requirements, and the absence of hot-shortness. Similarly, a high tensile and low ductility suggests a need for high loads and a limited capacity for deformation without cracking.

If such tensile tests are made under conditions of high strain rate, the results are more valuable where brittleness or hot-short ranges are present. This is especially true in the case of copper and copper base alloys where a brittle range of temperature is present, indicating that any hot working must be carried out above the upper extreme temperature in this range. Conversely, materials such as aluminum alloys, and zinc show that the plasticity increases from that at room temperature, reaches a maximum then decreases, indicating that the metal should be hot-worked at or near the temperature corresponding to the maximum plasticity measured by elongation.

Tensile Testing at Low Temperatures

The study of mechanical properties of materials at temperatures below 68 F has been stimulated in recent years by development in high altitude flying and in the commercial storage of liquid gases. In the case of high altitude flying, a temperature of —130 F at between 50 and 60 thousand feet can be reached, and materials need careful selection in the design of load-carrying components to withstand these temperatures. Consequently, data on properties of metals down to —320.8 F (the boiling point of nitrogen at atmospheric pressure) are now required. Besides this data collection, various investigations into the study of the phenomena which occur in a material at low temperatures are being carried out especially from the viewpoint of the embrittlement of ferrous materials, which depends not only on the composition and history of the material, but also on the type of loading and strain rate.

The equipment for tensile testing at sub-zero temperatures follows the pattern outlined in the section dealing with elevated temperature testing, namely, the utilization of a standard type of machine with auxiliary equipment consisting of a cooling chamber in place of a furnace, and an extensometer which will give a measure of either the elongation or of the reduction in area with load.

A satisfactory design of cooling equipment has been described by Rees, Hopkins and Tipler[8], and is shown in Fig. 10. It is designed to boil organic liquids at pressures up to atmospheric, so that any temperature from the triple point to the boiling point may be obtained. The refrigerant is contained in a large Dewar flask closed by a metal cover and rubber bung, the seal being made by a rubber sleeve. From the side of the metal cover, an outlet pipe passes via a large air trap to a rotary vacuum pump. This air trap reduces the back pressure set up by the solubility of the vapor of the refrigerant in the vacuum pump oil. The pressure, and hence the temperature of the refrigerant, is adjusted by an air leak into the flask.

Since the tensile tests must be carried out at atmospheric pressure, provision is made for the low temperature existing in the flask to be transferred to a cooling chamber by means of a suitable liquid, which is circulated by a small centrifugal pump through a copper coil immersed in the flask, and then around the test specimen. The whole apparatus is insulated with a suitable material, such as glass or slag wool, or granulated cork.

The above method of using the relationship between pressure and temperature of a liquid enables any temperature to be obtained between the triple and boiling points of the liquids. Such liquids suitable for particular ranges of temperatures are tabulated in Table III.

Probably the best circulating liquid to use is isopentane, which has the widest range of temperature, permitting tests to be made from room temperature to approximately —256 F. Temperatures down to —108 F can be obtained without using the above

TABLE III

Circulating liquid	Boiling point at 760 mm. Hg, F	Triple point, F	Freezing point, F
Methyl Chloride	− 11.5	−143.8	.....
Ethylene	−155	−272.3	.....
Acetone	+132.8	.....	−138.2
Methane	−263	−297.5	.....
Freon 12	− 21.6	−247	.....
Freon 13	−114.7	−294.6	.....
Isopentane	+ 82.4	.....	−256
Nitrogen	−320.4	−346	.....

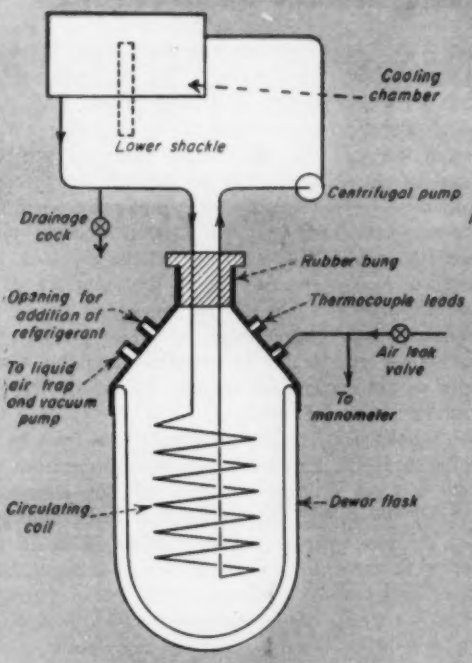


Fig. 10—A cooling apparatus for low-temperature testing,[5] which is designed to boil organic liquids at pressures up to atmospheric. Temperatures from the triple point to the boiling point may be obtained.

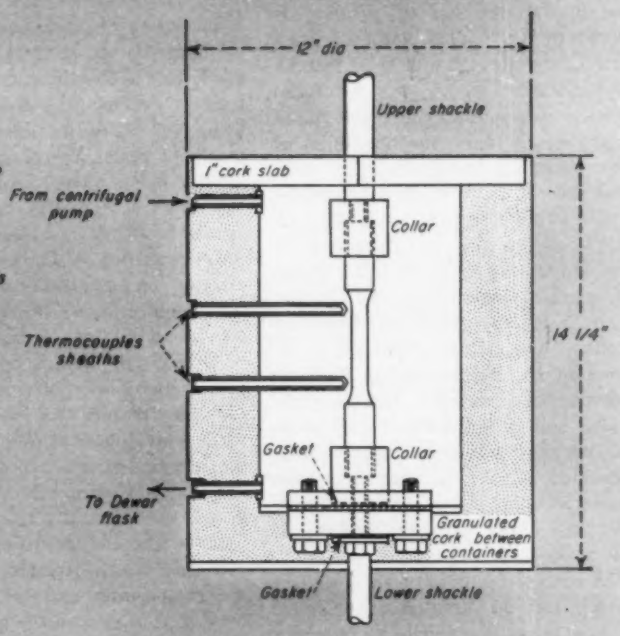


Fig. 11—The general arrangement of a cooling chamber for low temperature testing. Temperature measurements may be made by thermocouples with a soaking period of 30 minutes, before testing. The best circulating liquid to use is isopentane.

TABLE IV—Effect on the Tensile Properties of Various Materials at Low Temperatures Down to —148F

Metal or Alloy	Yield stress	Ultimate tensile stress	Percent elongation	Percent reduction of area	Young's modulus
Mild Steel	Increase	Increase	Decrease	Decrease	Increase
Austenitic Nickel Steel	"	"	Slight Decrease	"	"
Cast Manganese Bronze	"	"	Decrease	"	"
Rolled Brass	"	Slight Increase	Slight Increase	Unaffected	"
Cast Aluminum Bronze	"	Increase	Decrease	Decrease	"
Electrolytic Copper	"	"	Slight Increase	Slight Increase	"
Aluminum and Alloys	"	"	Unaffected	Slight Decrease	"
Titanium	"	"	Decrease	Decrease	"
Lead	"	"	"	"	"

equipment, by immersing the test specimen in a bath of acetone cooled by adding solid carbon-dioxide to give the required temperature.

The lower shackle of the tensile testing machine passes through the bottom of the cooling chamber and a suitable gasket material is required, depending on the circulating liquid employed. In the case of isopentane, a good gasket can be made from neoprene sheeting, but if nitrogen is used for temperatures below the freezing point of isopentane, then a heavy grease may be used. Details of a suitable cooling chamber are shown in Fig. 11.

In the designing of shackles for low temperature testing, it is essential that axial loading be obtained. For the majority of materials, the elongation decreases with a lowering of temperature, and a slight eccentricity in loading superimposes a bending stress on the uniform axial stress which may lead to premature failure in materials of low ductility. This non-uniformity in stressing produces an appreciable amount of scatter in test results, making it necessary for more tests to be carried out in a given test program in order to produce statistically correct mechanical properties.

The measurement of extension in low temperature testing in normal laboratory atmospheres is difficult, due to the formation of ice which hinders any sliding movement of the extensometer rhombs in an optical system, and to the fact that any extensometer arms cannot come out through the bottom of the cooling chamber, because of sealing difficulties. Zambrow and Fontana[6] have utilized the Tuckerman Optical Strain gage fitted with

extension arms, which is suited to the measurement of extensions on the order of 2 x 10^{-6} inches. It was found necessary, however, to remove the extension arms from the specimen after the 0.2 percent proof stress had been reached to avoid breakage of the attaching screws. To do this, the load had to be removed, the specimen taken out of cooling chamber, then reinserted and loaded to failure.

An alternative method for strain measurement is to use the reduction of area as a measure of the ductility of a material. Special gages have been designed in which the minimum diameter of the specimen is measured during test. Such gages are either of the wholly mechanical lever type, in which the reduction in diameter is magnified by a lever system and measured on a dial gage, or of the mechanical/electrical type in which an autographic recorder gives the load-diameter relationship.

There have been many investigations of the effect of progressively lowered temperature on the properties of metals and alloys. Iron, mild steel, zinc, and zinc alloys exhibit a serious loss of ductility at low temperatures. Most other commercial non-ferrous alloys, including aluminum and copper base alloys, are not affected to any important extent. No precautions to guard against brittleness at low temperatures need be taken in the case of aluminum, magnesium, or copper base alloys. In the case of ferrous alloys, lowering the temperature increases the yield and ultimate strength at the expense of ductility, the increase in tensile strength being accompanied by an increase in hardness.

The most striking effect of low temperature in the case of steels, is the effect on the mechanical properties in the presence of stress raisers such as notches. As the temperature is lowered, the mode of failure changes from the ductile shear type of failure normally encountered at room temperature, to a brittle cleavage fracture with little or no ductility.

Fig. 12[7] shows the variation in tensile properties for iron and various carbon steels, showing that the tensile properties at —290 F. in all cases have increased approximately 100 percent over those at room temperature. Over a major portion of this temperature range there is no definite decrease in ductility as measured by elongation and reduction of area. It must, however, be emphasized that these characteristics give no indication whatever of the impact resistance at low temperatures (corresponding to a high rate of strain), or where stress raisers are present in the test specimen. In the case of the Armco iron, the notched bar impact value at room temperature was 78 ft.-lb., but at —100 F. it was only 4 ft.-pounds. Corresponding figures for the mild steel plate are 52 ft.-lb. at room temperature, and 1.5 ft.-lb. at —51 F. It is usual for low temperature service steels to be tested at room temperature in simple tension and in the notched impact test at low temperatures.

Table IV sets out the temperature dependence of the tensile properties for various types of alloys.

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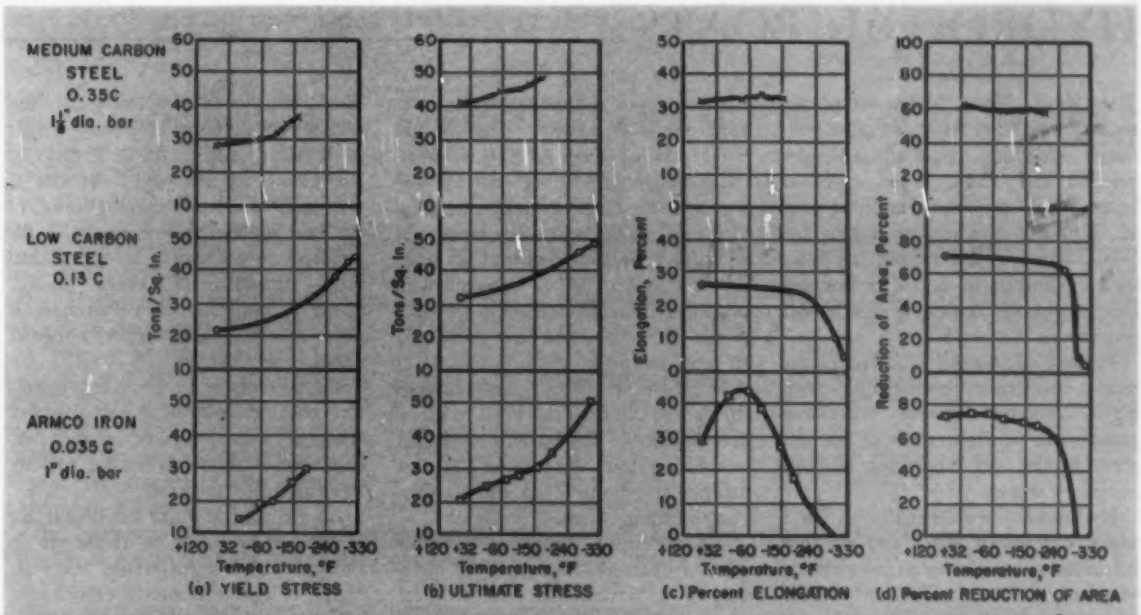

MEDIUM CARBON STEEL 0.35C 1⅛" dia. bar
LOW CARBON STEEL 0.13 C
ARMCO IRON 0.035 C 1" dia. bar
Tons/Sq. In.
Elongation, Percent
Reduction of Area, Percent
+120 32 -60 -150 -240 -330
Temperature, °F
(a) YIELD STRESS
(b) ULTIMATE STRESS
(c) Percent ELONGATION
(d) Percent REDUCTION OF AREA

Fig. 12—The variation in tensile properties for iron and various steels.[7] Over the major portion of the range from room temperature to —290 F there is no definite decrease in the ductility as measured by the elongation and reduction of area.

TECHNICAL NEWS

WITH ITS HULL RAISED OUT OF THE WATER, U. S. Navy experimental hydrofoil boat roars through a test run at high speeds. Navy is developing such vessels to serve as emergency craft, capable of navigating through rough and choppy waters.

HYDROFOIL BOATS

THE U. S. NAVY has removed the security veil from its hydrofoil experiments revealing that they have developed and tested several types of boats which can rise completely out of the water and run on submerged "water wings". Commander J. J. Stillwell of Bureau of Ships Preliminary Design Branch described the Navy's progress in this work.

Purpose of the foil is to reduce the boat's resistance permitting much higher speeds without increasing power, and to avoid some of the unpleasant and speed reducing motions caused by waves.

Hydrofoils are actually airfoils which operate in water and produce lift in the same manner as the airplane wing does in air. Only difference: greater density of water produces over 500 times as much lift per unit of foil area, so boats need only small wings.

The idea is not new. Comte De L'Ambert took out a French patent in 1897 on such a boat. The Wright Brothers tried their luck with hydrofoils shortly after their success with aircraft. But the first really successful hydrofoil boat was developed by Alexander Graham Bell and his associate Baldwin in 1907. Powered with two Liberty aircraft engines developing a total of 700 hp, this boat made over 70 mph on foils.

During World War II, the Germans built an 80 ton craft designed to travel over 50 knots. The boat foundered at sea during tests because of lack of stability and brought an end to German wartime efforts.

When stopped or proceeding at low speed a hydrofoil boat uses the buoyancy of a conventional boat hull for support, underwater hydrofoils and supporting struts give it greater resistance, less speed for equal power.

As speed is increased the lift produced by the foils unloads the hull and finally supports the entire weight of the boat, lifting the hull clear of the water. At this point, the loss of frictional and wave-making drag of the hull reduces the resistance of the foil boat below that of a conventional boat. At 40 to 50 knots "flying" speed a moderate sized foil boat is using only half the power of a regular vessel.

Major obstacle in designing hydrofoil boats is evaluating the complex effect of water surfaces on the performance of foils and on the stability and control of the craft.

An airplane in flight has no surface to contend with. A 50 ft change in altitude will not materially affect its flight. A hydrofoil, on the other hand, has a strict band of submergence (altitude) in which it must fly. This band is limited by the foil coming too close to the water surface, losing its

lift and causing a "crash"; or by the foil going so deep that the hull comes in contact with the water surface which also ends flight. In even a large foil boat, this altitude range is only a few feet requiring very precise control.

Based on methods to provide control and stability foil boats are divided into two general categories: surface-piercing foils and totally submerged foils.

In the former, the foil is usually given a V-shape (high dihedral) and is designed so that the upper half is out of the water at flying speed. Then if the foil attempts to go too deep, this extra area is immersed and the added lift causes the foil to move upward until the correct level is reached.

The totally submerged type does not automatically seek the proper submergence. Its angle of attack is controlled by an electrical, mechanical or hydraulic servo system that measures the height of the hull from the water surface and signals either rise or dive to the foil, keeping it at the precise level required. The action of either of these systems is complicated by the confused and unpredictable motions of the water surface waves.

Another complex engineering problem is how to propel such a boat. At reasonable speeds for marine craft, the air propeller is relatively inefficient, so a marine propeller is normally used. This requires the transmittal of power from a power plant in the hull down through shafting and struts to a propeller at about the level of the foils—even in a small boat, a vertical distance of several feet. In addition, the device must present a thin streamlined form to the water flow or lose the low resistance advantage of the foil boat.

The retraction of foils and propulsion gear is desirable if the boat is required to operate around piers. Retraction of the propeller and its driving gear is particularly troublesome, since the propeller and its strut and shaft must be made to deliver the required thrust in either of two positions: at the level of the foils and several feet higher at the ordinary position of a boat propeller.

The Navy sees several uses for the high speed boats. Sporting boats with relatively cheap hulls and outboard motors, if equipped with foils, would put high speeds (30 to 40 knots) within the reach of the average boat enthusiasts. Patrol boats or emergency boats of various types could race to the scene of action without slowing down for rough or choppy seas. Premium, fast, comfortable passenger service could be established at reasonable operating cost for the daily commuters.

A foil boat cannot reach aircraft speed. Nor will it ever replace the ship, since it is limited in size to hundreds, rather than thousands of tons. Also it can never compete for economy with a slow speed ship. However, hydrofoils offer the only known means of substantially increasing the speed of small boats.

The late William E. Kennedy

W. E. KENNEDY DIES

SHORTLY AFTER REACHING HIS OFFICE in the McGraw-Hill Building on Monday, July 13, Mr. William E. Kennedy, Asst. Publisher, *Product Engineering*, became seriously ill and was taken to the company infirmary. He died there—before an ambulance, called immediately to take him to a hospital, had arrived.

A mechanical engineering graduate of Cornell University, Class of 1912, W. E. Kennedy became advertising manager of International Nickel Company and in 1923 he joined McGraw-Hill. He was soon assigned to the business staff of *American Machinist*. In 1929, as manager of *American Machinist* he was one of those who laid the ground work for the launching of *Product Engineering* and served as its manager until 1945 when he was made assistant publisher of *American Machinist* and *Product Engineering*.

Bill Kennedy had a record of many accomplishments and abilities of which he had a right to be proud. He was among the best known men in the machine tool industry and was highly regarded for his knowledge and understanding of the problems of that industry. He was active among the members of the National Machine Tool Builders Association and for many years served as Chairman of the Program Committee of the American Gear Manufacturers Association.

But of all of Bill's accomplishments, the one about which he was most proud was the work he did in getting *Product Engineering* established. With the first issue dated January 1930, it was not long before the publication found itself struggling in the world's worst depression. Only careful management and courageous leadership carried the new publication through those difficult years. In 1945 "Bill" Kennedy had the great satisfaction of seeing *Product Engineering* establish new publishing records and rise to a position close to the highest of the McGraw-Hill publications. That year he was made assistant publisher.

He is survived by his wife, the former Hazel Mae Slade; two sons, Lt. Slade Kennedy, now on active duty with the U. S. Marine Corps, and Mr. William A. Kennedy; and a daughter, Mrs. David E. Bullard.

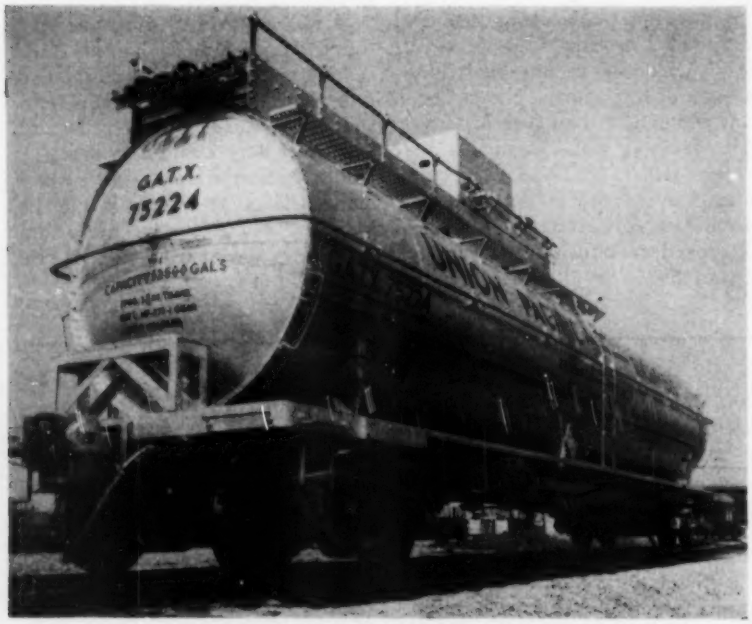
Bill Kennedy was one of those rare individuals about whom it can be truthfully said: "I never heard him speak a mean word about anyone." He had a host of friends.

RUSSIAN LATHE

Soviet radio claimed last month that the Kolomna Heavy Engineering Works was building a vertical lathe to machine turbine parts ranging from 30 to 43 ft in diameter. The Moscow company says that the machine will weigh 500 tons and will handle parts weighing up to 170 tons.

U. S. machine tool experts think the Russians actually are building a boring mill. Machines of this size are common in British and American turbine manufacturing plants and do similar work.

LOCOMOTIVE powered by propane-burning gas turbine will enter regular freight service soon on the Union Pacific Railroad. Weighing 276 tons, the engine unit delivers upwards of 4,800 hp and can handle a 79-car train of 4,650 tons. Top speed is 65 mph. Propane, with an octave rating of 125, burns without smoking, promising cleaner operation and reduced turbine maintenance. There is one disadvantage: noise. Exhaust noise, originating as 15,000 cfm of store gases are discharged at a velocity of 150 mph, is considerable at close range. It dissipates quickly with distance because the sound has no dominant pitch.



TENDER looks like ordinary tank car but has several modifications to feed propane to locomotive. Most important is the intricate valving and control system mounted on top of tank superstructure. Inside, there is a heat exchanger through which steam is passed to increase the pressure under which the propane is confined. The actual propane container is protected by a four-inch outer layer of cork and the metal covering visible above. Cooperating with the Union Pacific Railroad in the development of this locomotive and tender were General Electric Company who designed the turbine and Richfield Oil Company.

MILITARY ELECTRONICS

WASHINGTON—With Navy authorities predicting a 40 percent cut in military electronics procurement this year, military planners are wondering how they can maintain the electronics industry at sufficient strength to meet any future emergency. There's a two-fold problem: 1) the government wants the industry to keep minimum production facilities, and 2) at the same time, keep the army of carefully trained technicians required to build military gear at work.

To date there's been no finalized program set up. All the services are waiting for a master blueprint from the Secretary of Defense. Eisenhower's Defense Department has different ideas than their predecessors, particularly concerning secondary sources. But the two services most seriously concerned—U. S. Navy's Bureau of Ordnance and the U. S. Air Force—have been dropping unofficial hints as to what they would like to see happen.

The Navy advocates government storage of a selected amount of essential equipment. In addition, they think that a few companies should be kept in the business, turning out small quantities of military equipment and components.

The Air Force feels about the same. They recommend establishing a nucleus of essential plants to supply a minimum flow of gear.

GM STARTS SCHOOL MAGAZINE

GENERAL MOTORS has started publication of a technical magazine aimed at bringing the latest GM developments in research, design and production to engineering educators and students. Called the *GM Engineering Journal*, the new book made its first appearance with a June-July issue; henceforth it will be issued bimonthly during the school year, and once during the summer months.

Contents will include signed articles by the company's engineers in many varied fields of engineering, designed to assist college instructors by supplementing classroom presentations with the latest ideas and information about their particular course subjects.

GERMAN RESEARCH

FRANKFURT — Western Germany spent $114,000,000 for research last year according to a report recently issued by the U. S. High Commission in Germany. Scientists made no outstanding technological advances; the major portion of funds went to improve German products for the export market and to complete rehabilitation of war damage.

More significant than the actual figures reported, is the structure of Germany's research organization also revealed by the HICOG announcement. For example, the study shows that eighty percent of all scientific studies were conducted at universities, technological institutes, and scientific institutes of university rank.

Major Factors

Bulk of German research, both basic and applied, is carried out or supported by four organizations.

• **In the German Research Association,** there are members representing almost every scientific establishment and organization in Western Germany. Membership includes sixteen universities, eight technical colleges, eight other institutes of university status, four academies of science, and two technical scientific associations. Main purpose of the group is to further scientific cooperation by administering mutual interests and financially supporting research.

Last year the Association, which emphasizes basic research, spent slightly over $2,000,000, distributed: Social Sciences, 18 percent; Medical Science, 25 percent; Natural Science, 40 percent; Technology, Agriculture and Forestry, 17 percent.

• **The Fraunhofer Society for the Advancement of Applied Research** is the only group concerned solely with the support and development of applied research. Their chief function: the improvement of industrial methods. The society operates only one facility itself, a spectro-chemical lab in Munich. All other projects are referred to technical institutes maintained by universities, or to private laboratories of large industrial organizations.

These are current top level projects of the society: 1) the development of new ceramic materials, 2) study of the chemistry of crude oil, 3) experiments in the use and efficiency of gears, 4) development of new spectrochemical methods, and 5) development of synthetic fibres.

• **The Max Planck Society for the Advancement of Science** is a post war organization that replaced the Kaiser Wilhelm Society in 1948 and which is financed by the separate German States. Their subsidy runs about $3.5 million a year; they pick up an additional half million dollars every year from private donations.

Projects of this group fall into three classes: 1) biology and medicine, 2) chemistry, physics and technology, and 3) pure sciences. The Society is a leader in nuclear research and automatic computer studies.

• **The Donators' Association for German Science** is another post-war group, founded in 1949 by German industry. The organization collects funds from industry and makes grants, primarily for research in universities and other institutes.

In 1952 they started publication of a series called "Scientific Research and the Economy". But the greater share of their funds are given to the German Research Association or members of the Max Planck Society.

Battelle Memorial Institute for Germany was established last October and construction has started on the first two buildings that will house a scientific library, laboratories, an auditorium and administrative offices. It is expected that Battelle will become an important factor in Germany's research.

Activity in Berlin

Berlin has grown into a research center despite the sharp political division. One of the best equipped organizations in West Berlin is the Material Testing Bureau, a government laboratory that conducts both pure and applied research. On request the bureau will develop new products and improved methods of production for independent firms.

In addition there are numerous private firms doing research in Berlin:

• Siemens & Halskem, conducts basic studies in the field of low voltages; they're doing applied research in communications equipment, precision measuring devices, electron microscopes, and high speed photographic equipment.

• Osram is experimenting with water cooled xenon high pressure lamps, capable of exceedingly high lumen outputs per power input.

• The Auer Corporation is developing protective clothing for handling radioactive isotopes.

West German Research*

Field of Research	Establishments in Operation	Number of Projects	Number of** Scientists
Medicine	274	1,163	1,683
Food and Agriculture	244	1,595	1,011
Biochemistry	128	736	675
Chemistry	410	2,446	2,816
Mining and Geology	163	422	782
Engineering	313	1,393	1,181
Physics and Mathematics	241	1,094	1,225
Applied Electricity	216	811	1,086
TOTAL	1,989	9,660	10,459

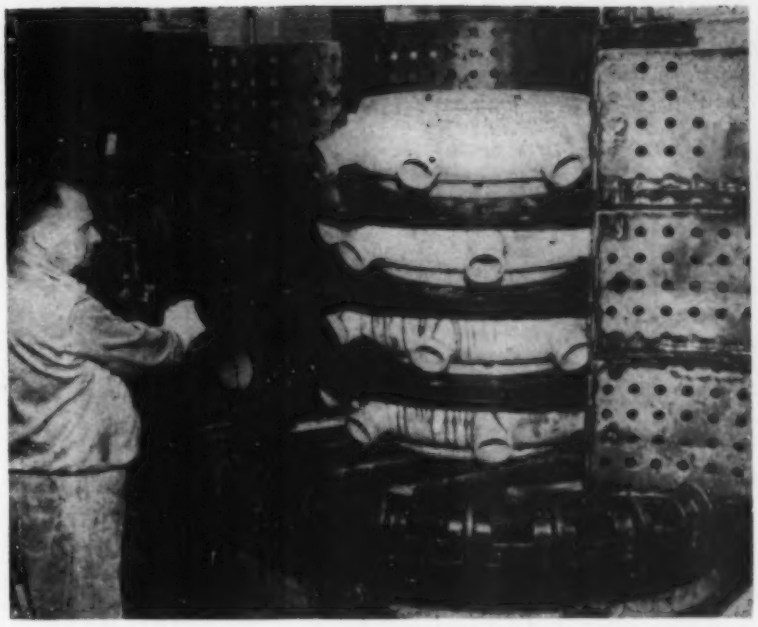
* Includes the Federal Republic of Germany and West Berlin. Statistics for the French area of control are as of December 31, 1952; statistics for the British and U. S. areas of control are as of November 30, 1952.

** Figures are for scientists and technicians working in research only, and do not include laboratory assistants and other non-professional workers.

THE NEWS IN PICTURES

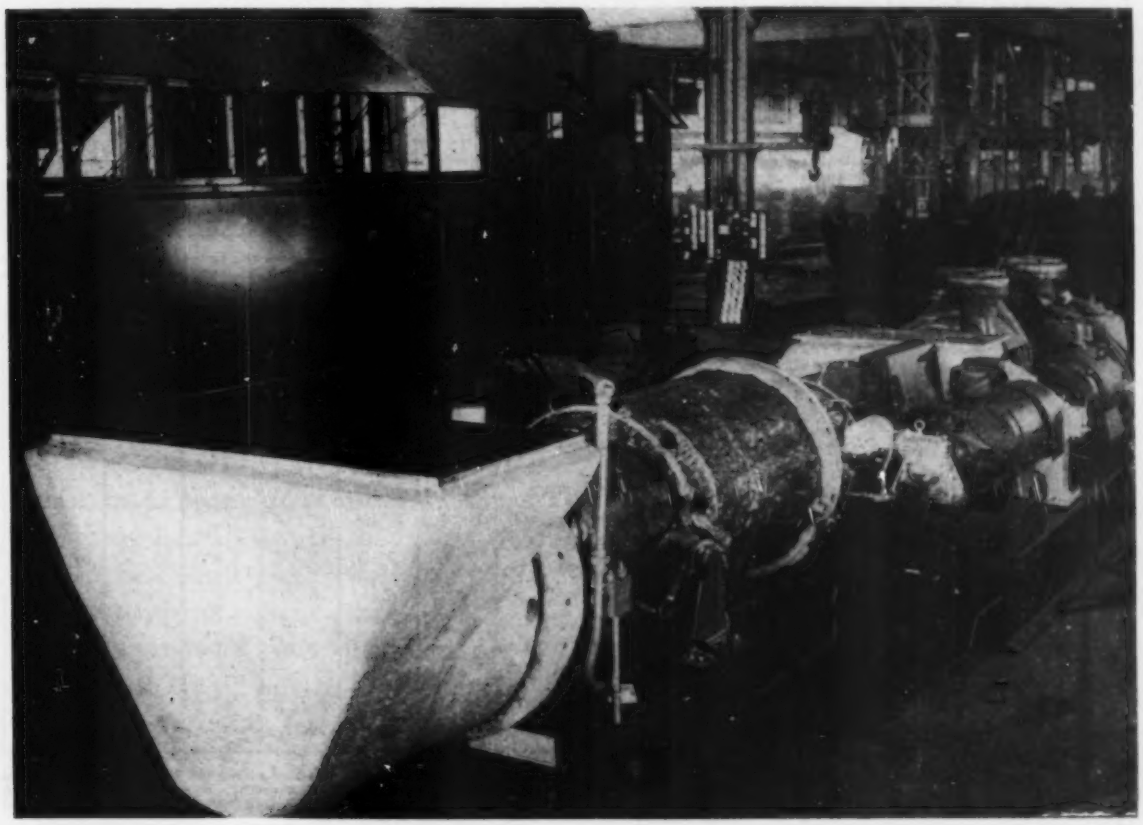
PORTABLE AIR STARTER COMPRESSOR, powered by gas turbine, cuts 500 lb of weight off combat aircraft in a significant design simplification. The tear drop-shaped unit is flown to forward airfields in the bomb bay of the plane, disengaged, and used as a ground starting cart to eliminate a built-in unit. Developed by Douglas Aircraft Company for the U. S. Navy's F4D Skyray, A2D Skyshark and the A3D twin jet bomber, it contains an AiResearch two-stage centrifugal compressor with a single stage radial flow turbine. The tear drop unit also has its own electrical starter, fuel and lubricating system.

PASSENGER CONVEYOR BELT, 60 ft long, set up in Stephens-Adamson Manufacturing Company's factory to test feasibility of such a device for moving people in large cities. From this study, engineers of the company and The Goodyear Tire and Rubber Company calculated that the nine foot wide strip would carry 16,000 people an hour with no waiting.



FIRST FULLY AUTOMATIC PROCESS for sealing porous aluminum and magnesium aircraft engine castings with liquid synthetic resin went into operation at Pratt and Whitney Aircraft. Jet and piston engine parts up to 80 in. in dia. are placed into this 1,500 gal autoclave for vacuum impregnation with GE's Permafil resin to make components oil-tight.

1800 HP GAS TURBINE built by Westinghouse Electric Corporation, will be installed in a trailer so that U. S. Army Corps of Engineers can test its suitability for supplying compressed air. The turbine, two multi-stage centrifugal air compressors, 50 hp starting motor, and 60 kw generator and auxiliaries are all mounted on a fabricated steel base plate. Gas turbine's high power output per unit weight and volume is major advantage of the unit, which operates on a simple open cycle.



PROFESSIONAL ENGINEERS' SALARIES

IN THE FOURTEEN YEARS since 1939, the average Professional Engineer in New York City has about doubled his salary. That's the conclusion to be drawn from a survey conducted by the New York City chapter of the New York State Society of Professional Engineers.

In a state where legislation has made the title "Professional Engineer" mean something, the Manhattan chapter decided last spring to find out how their membership was doing financially. They sent out 785 questionnaires and received 376 returns. From these it looked like most of the PE's in the nation's biggest city were doing all right.

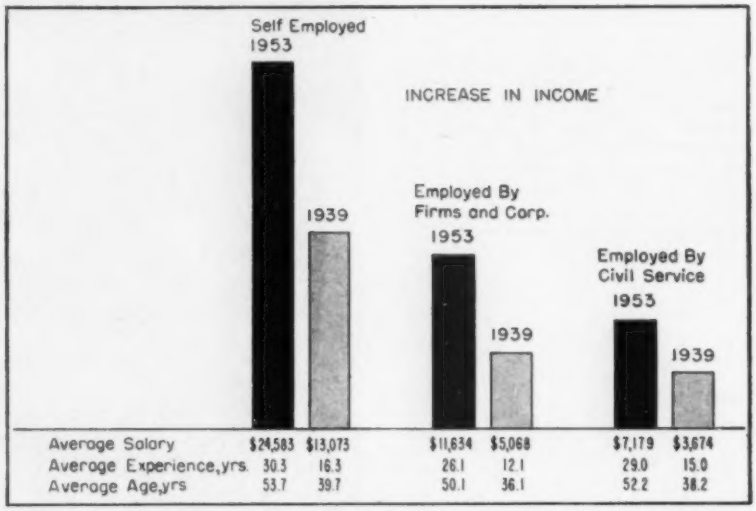
Three main categories were considered in the survey: self-employed PE's, those employed by private firms and corporations, and those employed in Civil Service. Also included were Engineers-in-Training (EIT)—those who have taken and passed the first part of New York's two-part Professional Engineering Examination.

The study clearly points up one fact. Engineers employed by government—city, state or federal—receive compensation at a rate that does not compare with that earned by those employed by non-government institutions. However such engineers usually have pension benefits.

Here are some interesting facts reported by the survey:

- Self-employed engineers, on the whole, made more money than those employed by either private firms or the government. Their salaries ranged from a top of $150,000 to a low of $6,000, averaging out at $22,307 per year.
- Licensed engineers employed by private firms reported annual earnings, without bonuses or overtime, as high as $95,000 and as low as $5,400.
- Professional Engineers employed in Civil Service trailed well behind the other two groups. Top annual pay reported was only $12,000, and the low dipped down to $3,600, despite experience averaging 27.9 years.
- Licenses covering more than one type of engineering pay off better than a single degree to engineers employed by private firms and corporations.

Other significant statistics are reported in the two tables and the graph.



	Professional Engineers			E.I.T.s
	Self Employed	Pvt. Firms & Corp'ns	Civil Service	
Number returns analyzed	57	239	35	38
Percent of total (369)	15.5	64.7	9.5	10.3
Percent of P.E.s. (331)	17.2	72.2	10.6	.....
Basic Income				
Maximum	$150,000	$95,000	$12,000	$8,500
Upper Decile	43,600	18,000	9,050	7,530
Upper Quartile	25,000	12,000	7,900	6,625
Median	16,000	9,000	6,630	5,830
Lower Quartile	11,500	7,300	5,846	5,000
Lower Decile	7,900	6,450	5,544	4,466
Minimum	6,000	5,400	5,025	3,600
Average	22,307	10,989	7,028	5,871
Av'g Yrs. Exper	28.6	21.6	27.9	4.0
Av'g Age, Yrs	52.4	45.6	51.4	28.1

In this analysis, salaries were arranged in order from the lowest to the highest. The middle figure is the "median", the figure one-tenth from the bottom is the lower decile, the figure one-fourth from the top is the upper quartile.

Classification	M. E.	C. E.	E. E.	Chem. E.	M. E. & E. E.	Misc.*
Number	67	62	73	12	10	15
Pecent of total	28.1	25.9	30.5	5.0	4.2	6.3
Basic Salary						
Maximum	$21,000	$30,000	$95,000	$20,000	$40,000	$50,000
Upper Decile	14,900	19,400	15,000	.....	.....	.....
Upper Quartile	10,000	12,000	11,750	12,875	15,000	23,000
Median	8,500	9,300	9,200	8,400	10,250	10,500
Lower Quartile	7,000	7,670	7,290	7,125	8,875	8,000
Lower Decile	6,213	6,495	6,500	.....	.....	.....
Minimum	5,400	5,400	5,400	6,300	7,200	6,400
Average	9,429	11,041	11,083	10,108	13,820	16,099
Av'g Yrs Exper	19.2	23.5	22.2	12.9	27.4	24.6
Av'g Age, Yrs	43.8	48.0	46.3	36.2	49.7	45.9

Analysis of 239 returns from Professional Engineers employed by private firms and corporations. Misc. includes: Industrial, General Consulting, Management, Naval, and Fire Protection Engineers. Also combinations of: CE and ME; EE and CE; ME and Metallurgical; ME and Aero E; Chem E and ME.

MANPOWER BOARD LEGISLATION

WASHINGTON — Despite vigorous urging by the Engineering Manpower Commission, Congress failed to act on the Flanders-Johnson Bill (HR 3893, S 1551) that would provide an impartial allocation of manpower according to the needs of the military and industry.

Main purpose of the legislation was to amend certain provisions of the Universal Military Training and Service Act passed by the 82nd Congress. UMT created a compulsory reserve so that inductees and enlistees were made liable for a total of eight years in the armed forces and reserve component. Present laws permit the Defense Department to order this reserve, which will eventually exceed 10,000,000 men, to active duty with no reservations or qualifications.

Senator Ralph Flanders proposed S 1551 to defer reservists having special proficiencies and experience, keeping them in a civilian status when that would contribute better to national strength and economy. The bill would establish a National Manpower Board in the Office of the President. To the board would be delegated authority to establish criteria for calling up reservists and to rule on appeals from calls of active duty made by those with special skills.

Introduced last spring, the bill was pigeon-holed in legislative committee. On March 15, both the House and Senate Armed Forces Committees asked the Defense Department for a report on the proposed legislation. No answer arrived during the current congressional session.

HEAVY PRESS CUTS

GOVERNMENT ECONOMY and the feeling that the program had been overly enthusiastic have led to deep cuts in the Air Force's Heavy Press Program (*Product Engineering*, December, 1952, p. 123 etc). Air Force Secretary Harold Talbott slashed the number of presses to be built from 17 to 10. As yet, Defense Department sources have not been able to calculate what this will mean in dollar savings.

The seven presses cancelled:

- 35,000-ton forge by E. W. Bliss Co. for Kaiser Aluminum & Chemical Div., Newark, O.
- 25,000-ton forge by E. W. Bliss Co. for Kaiser Aluminum & Chemical Div., Newark, O.
- 35,000-ton forge by United Engineering & Foundry for Harvey Machine Co., Torrance, Calif.
- 25,000-ton forge by Baldwin-Lima-Hamilton for Harvey Machine Co., Torrance, Calif.
- 20,000-ton extrusion by Loewy Construction Co. for Alcoa, Lafayette, Ind.
- 20,000-ton extrusion by United Engineering & Foundry for Harvey Machine Co., Torrance, Calif.
- 8,000-ton extrusion by Loewy Construction Co. for Kaiser Aluminum & Chemical Div., Halethrope, Md.

Untouched by the revision were these giant presses:

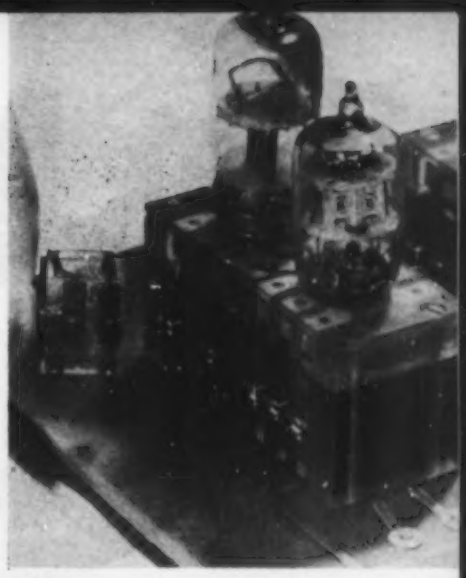
- 50,000-ton forge by Loewy Construction Co. for Wyman-Gordon Co., No. Grafton, Mass.
- 35,000-ton forge by Loewy Construction Co. for Wyman-Gordon Co., No. Grafton, Mass.
- 50,000-ton forge by Mesta Construction Co. for Alcoa, Cleveland, O.
- 35,000-ton forge by United Engineering & Foundry for Alcoa, Cleveland, O.

MORE POWDERED IRON

REPUBLIC STEEL CORPORATION will use a new process to produce powder iron commercially at a plant now under construction in Toledo. The company —first major steel producer to enter the powdered metals field—expects capacity to reach 25 tons per week, a major share of U. S. powdered iron supplies. (In 1951, U. S. estimated annual usage of powdered iron was only about 200 tons.)

In the past three years, demand for such powder has soared. Over 100 companies are now using the technique to form mechanical parts like gears. Republic also proposes to make powder for flame scarfing and cutting and for use in its own steel plants.

The new process, largely automatic and continuous in operation, will feed on iron ore supplied by both U. S. and African sources. It's a "direct reduction" method.



CELL SLIPPED into building block to connect tube to printed circuit.

CELLULAR ELECTRONICS

TO CONNECT ELECTRONIC components and tubes to sheets containing printed circuits, the National Bureau of Standards breaks the basic units of the circuit into cells and building blocks. Spring pressure forces contact instead of soldered connectors.

Key to the new technique: small three-contact molded blocks that contain one or two circuit elements like resistors, capacitors or inductors. The cells are grouped into building blocks, two tubes and 12 cells held together by rigid frame in each block. On the top surface of the block there is a spring assembly that contains the tube sockets. Screws fasten the block to the printed base plate. The cells slide between the tube socket and the base plate, lubricated by a thin film of grease that insures a noise-free electrical connection.

NBS feels that the two-tube block is an efficient size to work with. Any number can be fastened on a suitably printed base plate. In addition, scientists see these advantages: The cells are inexpensive, compact, easy to handle and store. They're sturdy; as long as the block is secured to the base plate, none of the cells can vibrate or shake loose.

Cellular construction permits quick replacement of components—in cells or building blocks—without the use of plugs and connectors that boost the cost of electronic gear. For easy maintenance, an entire block can be removed by loosening the screws that hold it to the base.

Muscular Power

that controls the McDonnell "Banshee"

Even before she leaves the deck of a Navy Carrier, her pilot has this swift jet under finger-tip control . . . elevator trim tabs and wing pins moved and positioned by Lear electro-mechanical actuators.

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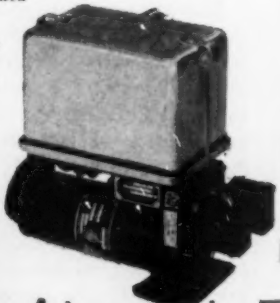
LEAR POWER UNIT Series 156
Typical of units designed for the McDonnell F2H-2. Specially developed as a power source, produced to meet specific aircraft requirements.



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LEARCAL DIVISION, LOS ANGELES, CALIFORNIA
LEAR, INCORPORATED, GRAND RAPIDS 2, MICHIGAN

Calculation of Dihedral Angles

WILLIAM W. JOHNSON

FORMULAS DEVELOPED by spherical trigonometry can be used to determine the angles required in constructing sheet metal products such as hoppers. Ten principal and five check equations are listed later for determining all the angles required in detailing the hoppers, and verifying the calculations. Ordinarily, only the first five of the principal equations are required but the attachments or supporting structure may necessitate the use of the next five.

Referring to Fig. 1(*A*) *M* and *N* represent two transparent planes which meet at their common intersection *OC*. Fig. 1(B) is another view of these planes. The angle *C* in the spherical triangle *ABC* is measured by the plane angle between tangents to *AC* and *BC*.

These tangents intersect radii *OA* and *OB* produced in *K* and *L*. Therefore, the numerical measure of the angle between the tangents to the great circles of a sphere at their points of intersection is the numerical measure of a spherical angle, and also the dihedral angle between the planes *M* and *N*.

The elements involved are defined as follows.

Given data:

- A = angle between plane M and plane of reference;
- B = angle between plane N and plane of reference;
- c = angle in plane of reference between its intersections with the planes M and N

Data which can be computed:

- C = dihedral angle between planes M and N
- b = angle in M, between its intersection with N and plane of reference;
- a = corresponding angle in plane N;
- m = angle in plane of reference between its intersections with M and a plane normal to the plane of reference through the intersection of the planes M and N;
- n = corresponding angle between intersections of N and the same normal plane;
- $m + n = c$;
- ψ = angle in normal plane between its intersection with reference plane and the intersection of planes M and N
- φ = angle between plane M and the same normal plane;
- Θ = angle between plane N and the normal plane.
- $\Phi + \Theta = C$

A horizontal plane may be chosen for the reference plane. If this is done, the plane normal to plane of reference is vertical.

(Continued on page 215)

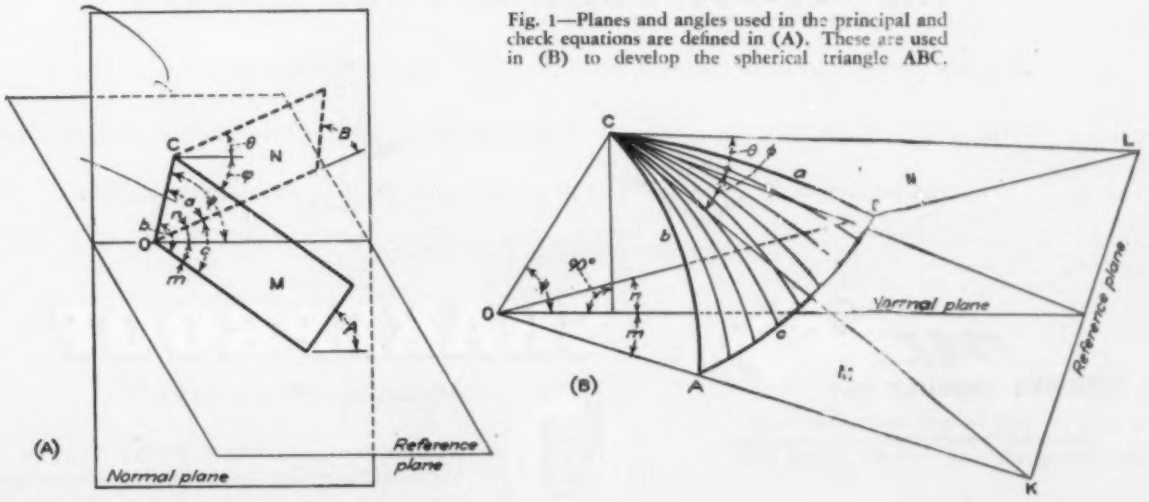
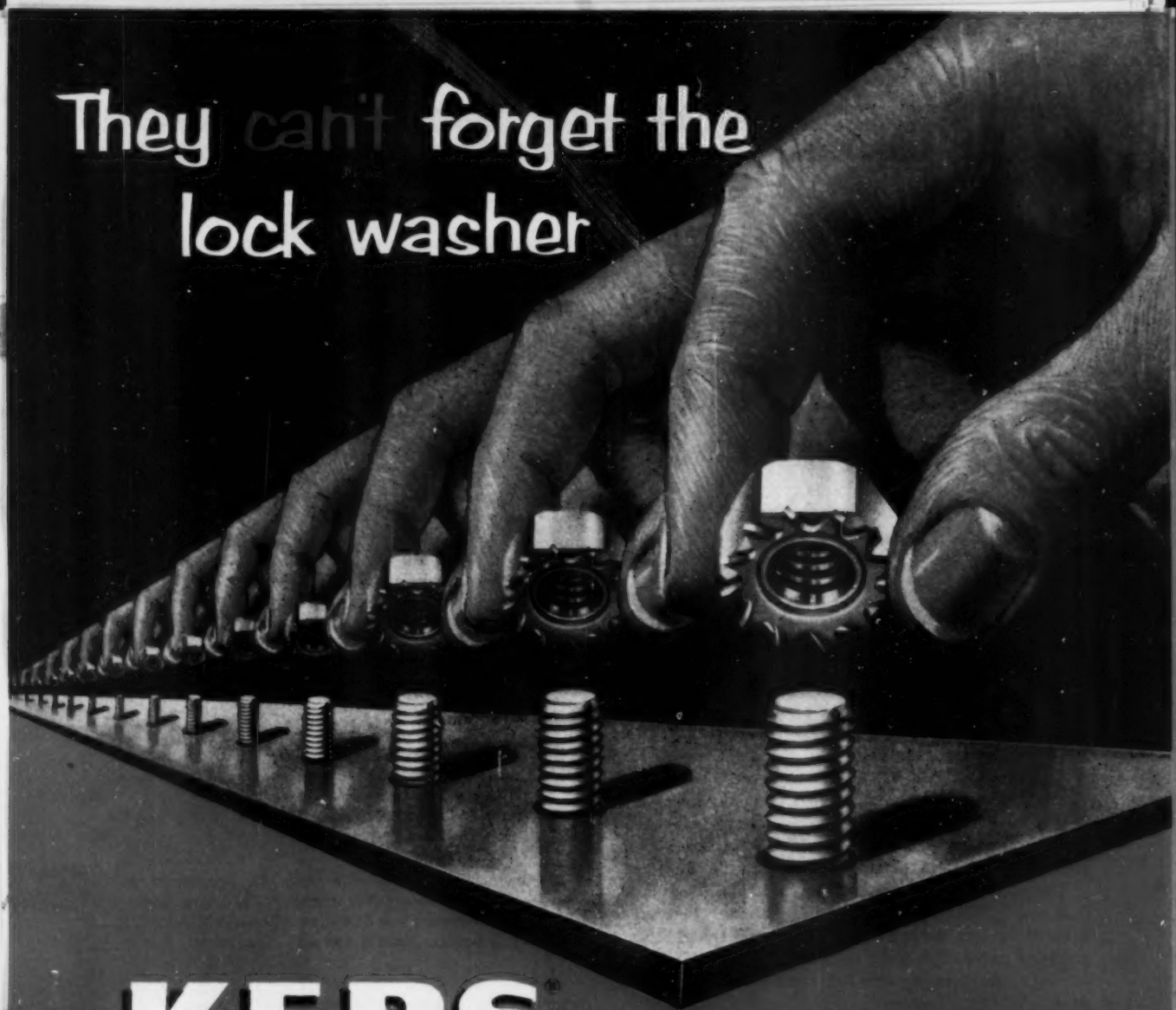


Fig. 1—Planes and angles used in the principal and check equations are defined in (A). These are used in (B) to develop the spherical triangle ABC.



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Calculation of Dihedral Angles (continued)

FORMULAS

$$\cos C = -\cos A \cos B + \sin A \sin B \cos c. \quad (1)$$

This formula can be modified for logarithmic computation by the use of an auxiliary angle x.

Letting $$\cot x = \tan B \cos c \quad (2)$$

Then $$\cos C = \frac{\sin (A - x) \cos B}{\sin x} \quad (3)$$

$$\sin a = \frac{\sin c \sin A}{\sin C} \quad (4)$$

$$\sin b = \frac{\sin c \sin B}{\sin C} \quad (5)$$

$$\sin \psi = \sin b \sin A = \sin a \sin B$$
$$\tan m = \tan b \cos A$$
$$\tan n = \tan a \cos B$$
$$\cot \Phi = \tan A \cos b$$
$$\cot \Theta = \tan B \cos a$$

CHECK FORMULAS

$$\tan \tfrac{1}{2}(a - b) = \sin \tfrac{1}{2}(A - B) \csc \tfrac{1}{2}(A + B) \tan(\tfrac{1}{2}c) \quad (I)$$
$$\tan \tfrac{1}{2}(a + b) = \cos \tfrac{1}{2}(A - B) \sec \tfrac{1}{2}(A + B) \tan(\tfrac{1}{2}c) \quad (II)$$
$$\cot (\tfrac{1}{2}C) = \cos \tfrac{1}{2}(a + b) \sec \tfrac{1}{2}(a - b) \tan \tfrac{1}{2}(A + B) \quad (III)$$
$$\tan \varphi = \frac{\tan m}{\sin \psi} \quad (IV)$$
$$\tan \Theta = \frac{\tan n}{\sin \psi}$$

In applying these equations, the algebraic signs must conform to Table I.

Table I—Sign Convention for Trigonometric Functions

Quadrant	Angles, deg	sin	cos	tan	cot	sec	csc
I	0–90	+	+	+	+	+	+
II	90–180	+	−	−	−	−	+
III	180–270	−	−	+	+	−	−
IV	270–360	−	+	−	−	+	−

SAMPLE PROBLEM

The outline of a hopper is shown in Fig. 2. Fig. 3 gives the development of the sides. This problem presents as many difficulties as are likely to occur in practice. Below is given the computation of the angles pertaining to the intersection of the sides M and N of the hopper. The lower horizontal plane is taken as the plane of reference. The pitch angles A and B are first computed from the given dimensions.

$$\tan A = \frac{41.625}{7.750} \qquad \tan B = \frac{41.625}{28.814}$$
$$\log \tan A = 0.7300525 \qquad \log \tan B = 0.1597416$$
$$A = 79° 27' 11'' \qquad B = 55° 18' 27''$$

Since the angle of the corner is given as 45 deg,

$$c = 135 \text{ deg.}$$

The dihedral angle C at the intersection of the sides

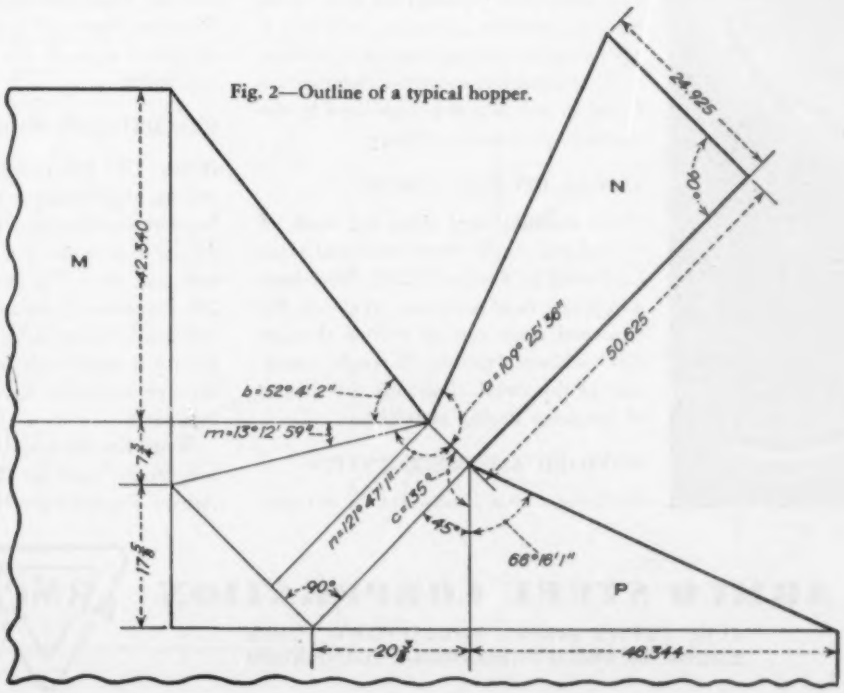

Fig. 2—Outline of a typical hopper.

Hardened Stainless Steel Piston Rings FLEX Without Breaking

Armco Stainless Steel piston rings are made for the tough jobs. These include high temperature applications such as seal rings for jet engines and steam turbines, and for actuating cylinders of aluminum die casting machines. Because of their corrosion resistance the rings are found in valves and pumps used by the chemical processing industry.

STRONG BECAUSE ROLLED

These stainless steel rings are made of rolled bar stock, stress-relieved after hardening to Rockwell C-48. They have a high degree of accuracy. As shown, the hardened rings can be twisted through 180° without fracture. Wrought condition of the metal eliminates the danger of breakage during installation.

STANDARD AND SPECIAL TYPES

Hardnesses up to Rockwell C-57 or better can be obtained with the standard hardenable chromium stainless steels, and Armco makes them all. In addition, there are the Armco Precipitation-Hardening Stainless Steels, 17-4 PH and 17-7 PH, hardened through low-temperature heat treatment.

PRECIPITATION-HARDENING TYPES

Armco 17-4 PH is a bar grade that develops high strength through a single, low-temperature heat treatment. Armco 17-7 PH is made in sheets, strip, plates, bars and wire. The grade is supplied in the annealed condition for severe drawing and forming. After fabrication, high strength and hardness are developed through a double low-temperature heat treatment.

Write for the booklet, "Armco Stainless Steels," and for the bulletin on the Armco Precipitation-Hardening grades.

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ARMCO

Calculation of Dihedral Angles (continued)

M and N is found from Eqs. (2) and (3):

Since log tan (E) = 0.1597416 and log cos (c) = 9.8494850,
log cot (x) = 0.0092266
Thus, x = 135° 36′ 31″ and
$(A - x)$ = − 56° 9′ 20″
Using Eq. 3 and log sin x = 9.8448227,
log cos C = 9.8297891 or
C = 132° 30′ 46″

Next, the angles a and b at which the sides M and N must be cut are found by Eqs. (4) and (5):

log sin a = 9.9745431
a = 109° 25′ 36″
log sin b = 9.8969296
b = 52° 4′ 2″

To check, use Eqs. (I), and (III), first finding $\frac{1}{2}(A + B)$ and $\frac{1}{2}(A - B)$ by addition and subtraction:

$\frac{1}{2}(A + B)$ = 67° 22′ 49″
$\frac{1}{2}(A - B)$ = 12° 4′ 22″

Thus,

log sin$\frac{1}{2}(A - B)$ = 9.3204661,
log csc$\frac{1}{2}(A + B)$ = 0.0347617, and
log tan$\frac{1}{2}c$ = 0.3827757.

Adding these three,

log tan$\frac{1}{2}(a - b)$ = 9.7380035 or
$\frac{1}{2}(a - b)$ = 28° 40′ 47″.

Similarly,

log cos$\frac{1}{2}(A - B)$ = 9.9902868,
log sec$\frac{1}{2}(A + B)$ = 0.4149709, and
log tan$\frac{1}{2}c$ = 0.3827757.

Adding,

log tan$\frac{1}{2}(a + b)$ = 0.7880334, and
$\frac{1}{2}(a + b)$ = 80° 44′ 49″.

Solving simultaneously,
a = 109° 25′ 36″ and
b = 52° 4′ 2″.

Therefore, log cos$\frac{1}{2}(a + b)$ = 9.2062731,
log sec$\frac{1}{2}(a - b)$ = 0.0568439, and
log tan$\frac{1}{2}(A + B)$ = 0.3802131.
From Eq. III, log cot$(\frac{1}{2}C)$ = 9.6433301 or
$\frac{1}{2}C$ = 66° 15′ 23″ and
C = 132° 30′ 46″.

The angles a and b are identified in Fig. 3 showing the development of the hopper on the plane of reference. The corresponding angles at the other intersection, or corner of the hopper, can be determined by a similar process.

The dihedral angle formed by the intersection of the sides N and P are:

angle C_1 = 140° 34′ 20″.

The cut angles for the sides N and P are:

angle a_1 = 90°. angle b_1 = 66° 16′ 1″.

The pitch angle for the side P is 63° 55′ 7″. (See Fig. 3).

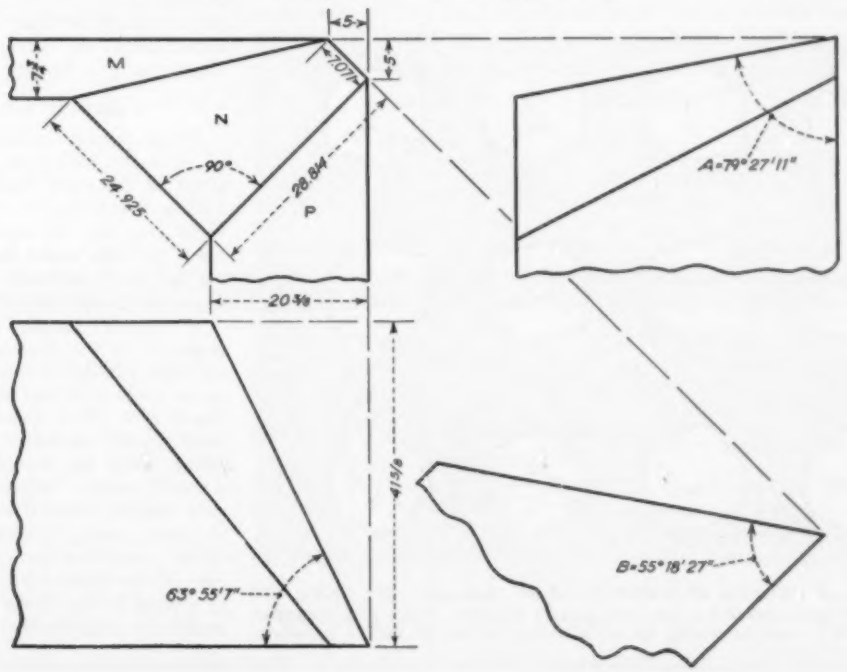
When the slopes of the sides M and N, and hence a and b are equal, and c = 90°, the required equations then become:

$$-\cos C = \cos^2 A \qquad (1)$$

and

$$\sin a = \frac{\sin A}{\sin C}. \qquad (4)\ \&\ (5)$$

Fig. 3—Development of sides of hopper of Fig. 2.



Drafting Machine Produces All Axonometric Views

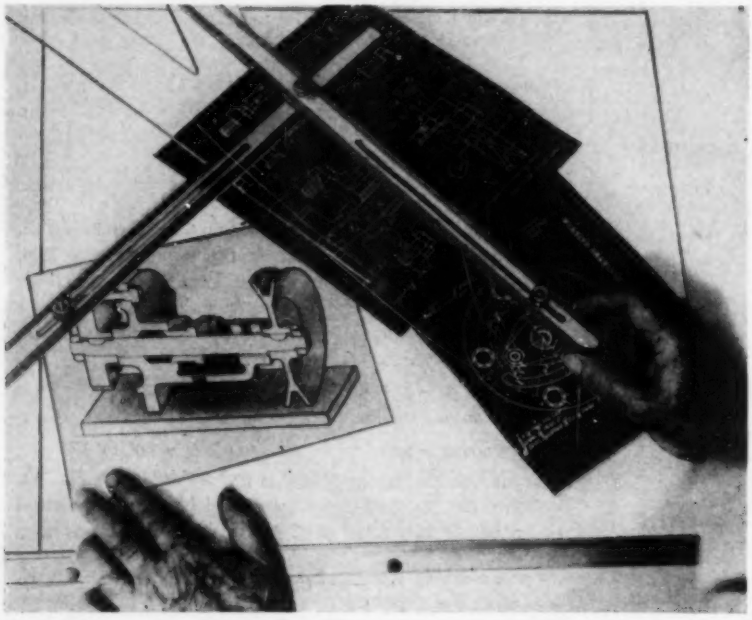


FIG. 1—In addition to producing cross-sectional drawings in axonometric projection, the drafting machine can draw an ellipse of any shape or size up to 20 inches, and can extend or condense a line of type by tracing it.

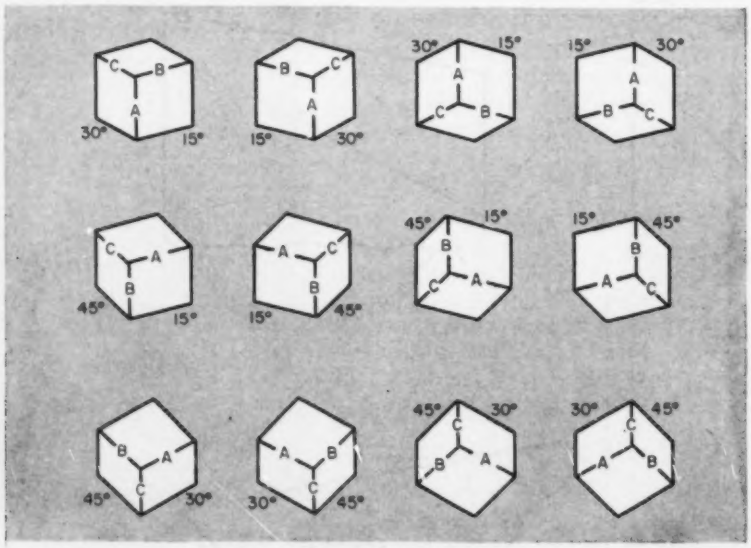


FIG. 2—A family of trimetrics, all orientations of the same cube. The tracing and marking link have been marked for use in the twelve positions shown plus isometric. The table at right is used in setting up an isometric or one of the 12 positions.

A different design in drafting machines has resulted in an inexpensive instrument that is capable of producing pictorial drawings in isometric, dimetric and trimetric views simply by tracing the normal orthographic views of the object, Fig. 1. Called the Adapto-Arm, the device is easy to operate, and having only three moving parts, it can be operated with a high degree of accuracy.

The instrument consists of a channel track of maple wood, 52 in. long, which is fastened to the drawing table, as shown in the illustration. The mahogany marking link and tracing link are maple laminated, and have a runner attached at one end of each link to permit free sliding in the channel track. The tracing link and the marking link are pivoted 24 in. from the runners, with slots in each link for fastening the marker and the tracer. The marker and the tracer are small chucks, designed for holding drawing leads, as in the case of the marker, or a steel point in the case of the tracer.

A straight edge is tacked to the drawing table at right angles to the channel track. The tracing board, which can be any piece of cardboard large enough to hold the drawings, rides along the straight edge and should have a straight bottom edge.

How It Works

Three normal orthographic views of an object have been arranged and taped to the right hand side of the tracing board, Fig. 3. One of these views was cut off and placed in a lower position, under the tracer. This will be called the lower view and the upper two views the upper views.

A scanner, usually a triangle, is mounted to the drawing table with an edge parallel to the lines of the upper views that read as shapes in the lower view. The scanning action is caused by the movement of the tracing board, while the scanner remains in a fixed position. Shapes on the lower view may be traced if the corresponding line is being located by the edge of the scanner in the upper views. A line on the upper view, which shows as a point on the lower view, may be drawn by holding the tracer on the

MATERIALS - PARTS

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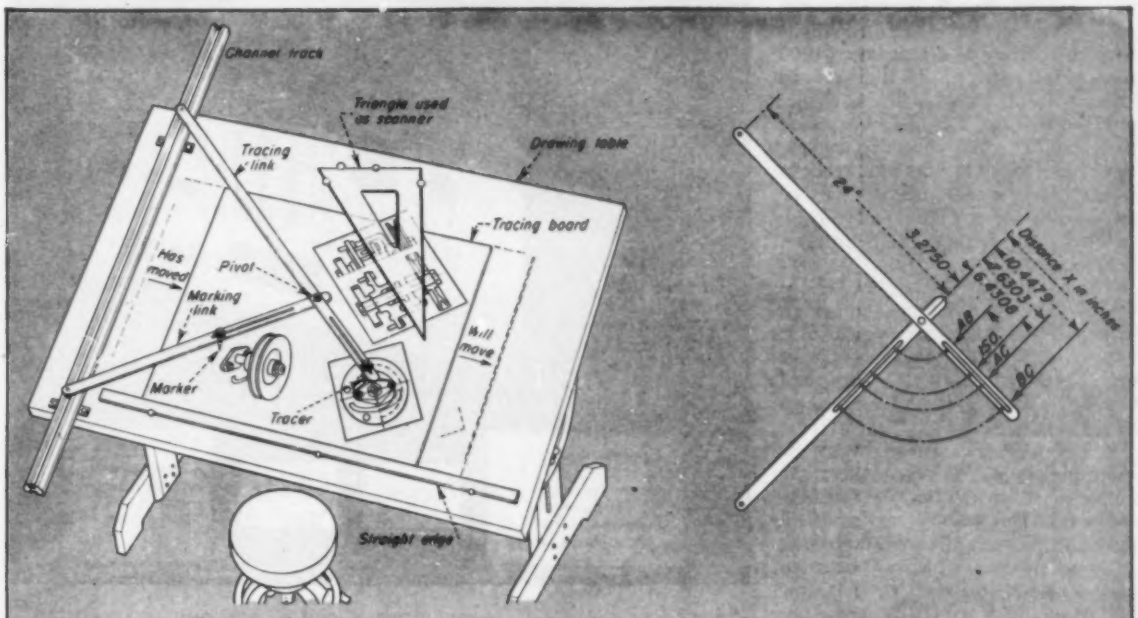

FIG. 3—With the reduction of a plane being measured by its minor axis, the following is true: a line forms an angle with the picture plane; the cosine of this angle is the coefficient of reduction of the line; and the sine is the coefficient of the reduction of the plane.

FIG. 4—The tracer and marker express the sine movement while the scanner gives the cosine. Or, the tracer and marker draw a plane, and the scanner draws a line perpendicular to it.

Plane	Distance in inches from Pivot	Minor Axis Reduction	Angle for Scanning	Angle for Tracing
AB	3.257	0.75984	21° 40′	37° 14′
ISOMETRIC	6.4308	0.57735	31° 10′	45°
AC	7.6303	0.51753	34° 19′	27° 22′
BC	10.4479	0.39341	41° 17′	34° 16′

point while the scanner passes over the line on the upper view.

As shown in Fig. 3, the view being drawn by the marker is in a trimetric projection. The distance between the pivot and the marker, which is equal to the distance between the pivot and the tracer, has been adjusted to a specific trimetric projection. The angle at which the upper views are mounted must relate to the adjustment of the tracer and the marker.

The angle of position of the views being traced may be any angle and the resulting drawing will be correct. For convenience it may be the same as the angle used for scanning; but if a specific projection is desired, a specific angle of position must be used.

The Adapto-Arm has been marked, Fig. 4, for use in the twelve positions of the family of trimetrics shown in Fig. 2, as well as isometric. And for further simplification, Table I shows a corresponding angle for different pivot and marker adjustments.

In solving for the distance x in Fig. 4, the formula $x = \frac{(Y \times 24) - 24}{-1 - Y}$ is used. Y is the minor axis or the desired reduction.

This formula may be used to adjust the arm to any axonometric drawing system.

The Wilkinson Co., Box 638, Arnold, Md.

CONTINUED ON PAGE 220

Voltage Converted To Decimal Digits

Operating upon demand, the Teleducer type 24 A automatically converts analog voltages into decimal digits with an accuracy of 0.1 percent (1000 counts full scale). It digitizes an input voltage, and holds the digital representation for a controllable period of time for purposes of display, recording, or any desired readout form. The digital output can be recorded by means of a punched card, an electric typewriter, magnetic tape, or punched tape.

The instrument digitizes low voltage without d-c amplification and high voltage by means of an attenuator. It uses a simple-bridge balancing circuit which does not hunt or oscillate, and requires only 0.8 second or less to reach balance.

The Teleducer is essentially a self-balancing digital potentiometer, the output of which can only be of integral values. This action is accomplished through the use of single direction stepping switches which are actuated in the proper sequences to cause the bridge voltage to equal the input test voltage. Null detection is provided by a high frequency chopper error amplifier.

Three stepper switches are used to permit digitizing over the range from 000 to 999. Each stepper has fixed resistors between position points, and the three steppers taken together form an integrally variable potentiometer.

The supply voltage to this potentiometer comes from suitably switched resistors and a 10-turn potentiometer (from a 3 volt battery source) such that full scale voltage across the potentiometer may set at any value from 20 millivolts to 1.0 volt. The sensitivity therefore may be any desired value between 20 microvolts per count and 1.0 millivolt per count.

The stepper switches always start from a reset condition and establish a potentiometer voltage balance with the input test voltage, but do so only upon external demand, in the form of momentary circuit closure. This action is accomplished by depressing the Readout button of the panel face, or by circuit closure from another source through the input Readout socket just below the Readout push button. During the period of reaching a balance, an indicator light labeled Balancing is turned on.

When balance has been achieved, a Null light comes on, and an externally available circuit closure is made. The use of this latter signal is to automatically start the recording unit.

Telecomputing Corp.,
133 *E. Santa Anita Ave.*,
Burbank, Calif.

Oil-Actuated Transmission Extends Performance

To get extended full-range performance from hydraulic torque converters, a new oil-actuated two-speed transmission has been designed to give a dual range of converter operation. The unit is equipped with a direct drive and a single stage planetary gear system. Two ratio spreads are available: direct drive with a 2.69:1 reduction ratio, or direct drive and 3.07:1 reduction ratio.

Besides the extended range of performance obtained, the new two-speed transmission is said to give greater shifting ease through the use of hydraulically actuated multiple disk clutches, and providing the selection of three operating positions: neutral; high or direct drive; and low or reduction gear drive. All positions in the range are controlled from a special spool-type valve mounted on top of the transmission.

Compact and rugged in construction, the new transmission is also designed for easy installation and simple maintenance. As a package unit, the transmission is matched to the three-stage hydraulic torque converter made by this company. Known as the model T-302, this new unit has applications ranging from oil field rigs to switching locomotives Also made by this company is an oil-actuated clutch that requires no adjustment to compensate for friction plate wear, and has snap rings for easy disassembly.

Twin Disc Clutch Co., Racine, Wis.

CONTINUED ON PAGE 222

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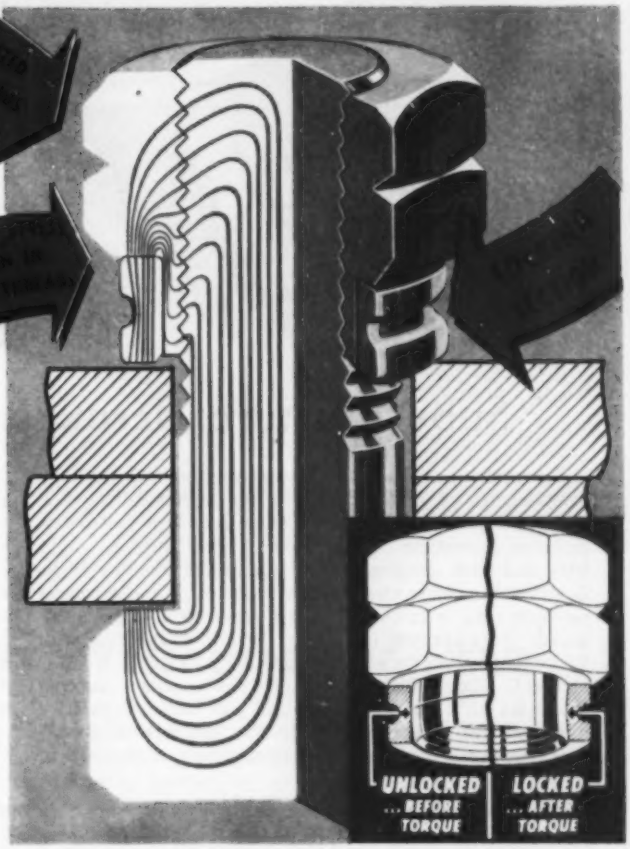
Klincher Locknuts are specially designed to give reliable performance in critical applications at temperatures up to 1600° F. The Klincher principle of load distribution reduces the high stress concentration and torsional load usually found in the first two or three threads. Even under severest vibration, nut remains positively locked and there's no danger of galling, seizure or stud wear . . . and nut remains fully re-usable.



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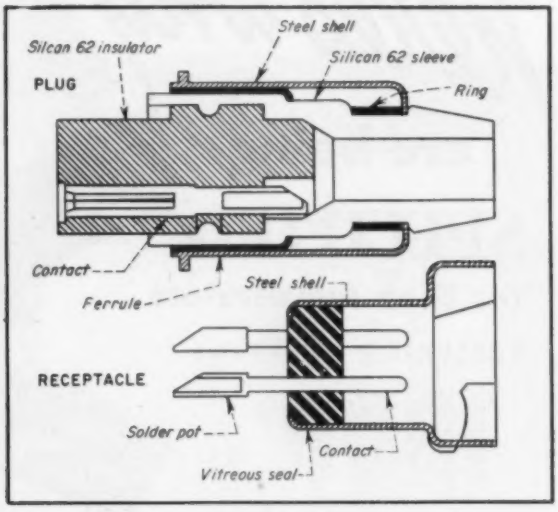


Sub-Miniature Hermetically Sealed Connectors

To meet the demand for smaller and smaller electrical components, sub-miniature connectors in the round shell design have been designed for use on miniature sealed and unsealed instrument switches, relays, transformers, amplifiers, and other components and equipment. Known as the U series, the connectors are now made in 3- and 6-contact arrangements, with single contact types soon to be introduced. An additional connector, the UE, is available with 12 contacts.

The U plugs with socket inserts have resilient material insulators of silicone material, and pin insert plugs have insulators of vitreous material. Pin contacts of the U connectors can be furnished with either solder-pot or eyelet terminals. One group of receptacles is hermetically sealed for solder applications, and another with a locknut for mechanical or solder applications.

Contacts are for 5 amperes current, with a minimum flashover of 1,700 v d-c, and polarization is achieved by a flat-top polarizing design. Engagement is made by the bayonet and "J" slots, which require less than $\frac{1}{8}$ turn of the coupling member to latch or unlatch. Shells are steel; finished in cadmium plate chromate dipped. The 3-contact plug weighs only 0.0088 lbs. and is $1\frac{1}{16}$ in. long, with a maximum diameter of $\frac{17}{32}$ inch.

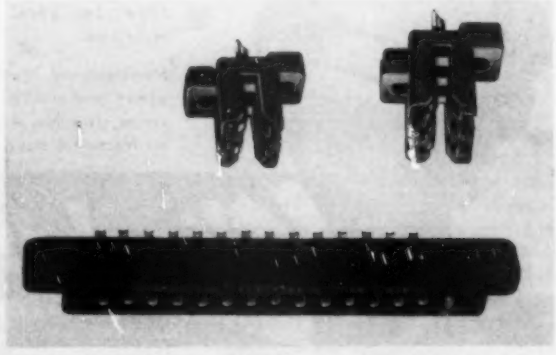
Cannon Electric Co., 3203 Humboldt St., Los Angeles 31, Calif.

Miniature Printed Circuit Card Receptacles

Printed circuit receptacles in sizes from 2 to 22 contact positions, permit easy removal and replacement of printed circuit cards for maintenance purposes, and easy external wire soldering operations. The K2S and the K3S units shown above in the illustration are suitable for limited space requirements, and can be used either individually or stacked side by side.

The larger unit shown at the bottom, model K15S, permits the use of a $2\frac{1}{2}$ in. wide by $\frac{1}{16}$ in. thick printed circuit card containing a maximum of 14 terminals and one polarizing slot. The polarizing pin in the receptacle can be located in any position required. Printed circuit cards with fewer terminals can be used by including additional polarizing slots on the card. The polarizing pin allows engagement in the correct position only, while the wiping action of the contact makes positive contact at all times.

Receptacles K6S and K18S are about the same as K15S and differ only in the size circuit card used. The



K6S has a maximum of 5 terminals, and the K18S has a maximum of 17 terminals.

Winchester Electronics, Inc., Glenbrook, Conn.

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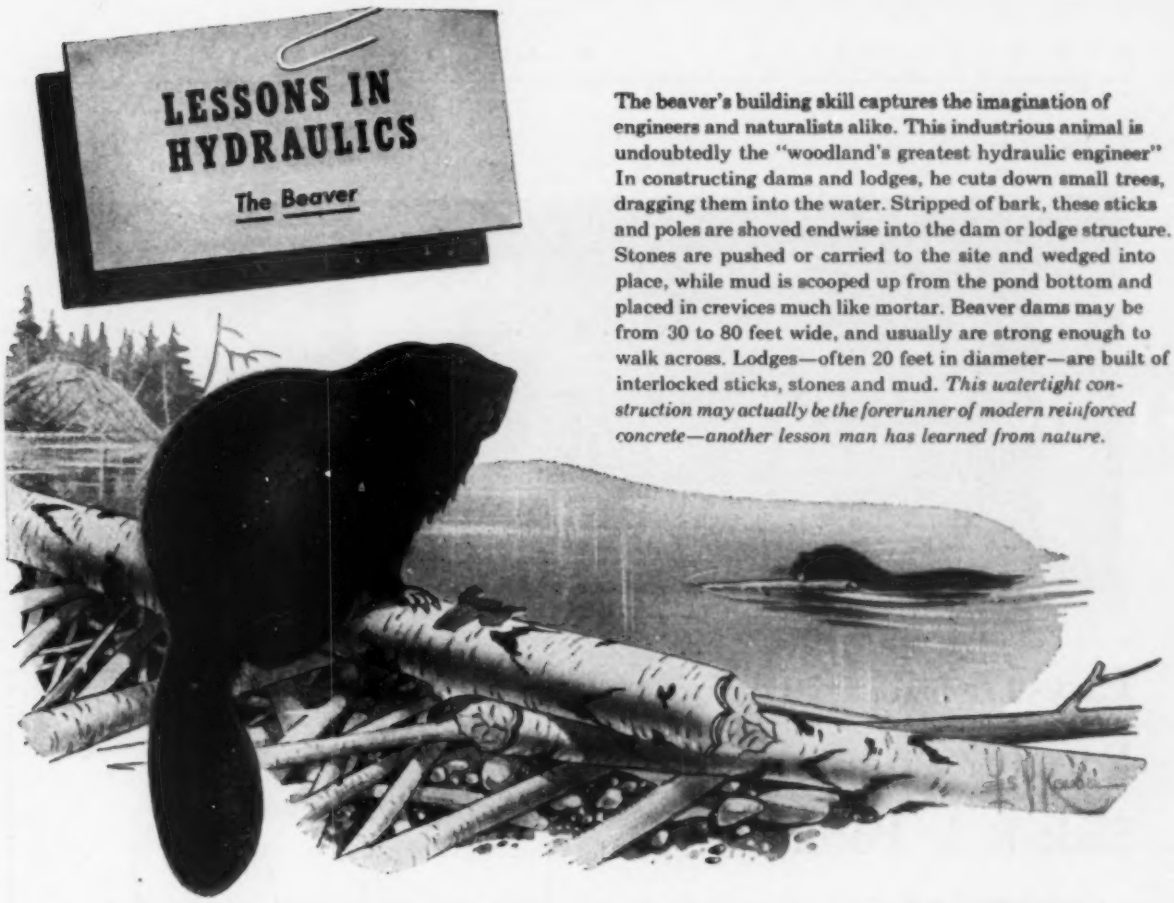

The beaver's building skill captures the imagination of engineers and naturalists alike. This industrious animal is undoubtedly the "woodland's greatest hydraulic engineer" In constructing dams and lodges, he cuts down small trees, dragging them into the water. Stripped of bark, these sticks and poles are shoved endwise into the dam or lodge structure. Stones are pushed or carried to the site and wedged into place, while mud is scooped up from the pond bottom and placed in crevices much like mortar. Beaver dams may be from 30 to 80 feet wide, and usually are strong enough to walk across. Lodges—often 20 feet in diameter—are built of interlocked sticks, stones and mud. *This watertight construction may actually be the forerunner of modern reinforced concrete—another lesson man has learned from nature.*

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Many products have design features requiring a hydraulic seal with special properties in addition to close tolerances and extreme uniformity. If yours is such a product, you'll want to know more about *injection molded* Minnesota O-Rings. Available in numerous compounds of natural or synthetic rubber, Minnesota O-Rings have great tensile strength, extreme capacity for pressure, and high resistance to compression set, abrasion, and oil swelling. Check these examples of successful installations in air, gas, and hydraulic systems: dispensing mechanisms . . . hydraulic rams and valves . . . air cylinders . . . remote control mechanisms . . . spraying equipment . . . gasoline and steam engines . . . and water pumps. Minnesota O-Rings are the choice of industries leading engineers and product designers. For prompt analysis and quotation on your requirements, send us your blue prints or specifications.

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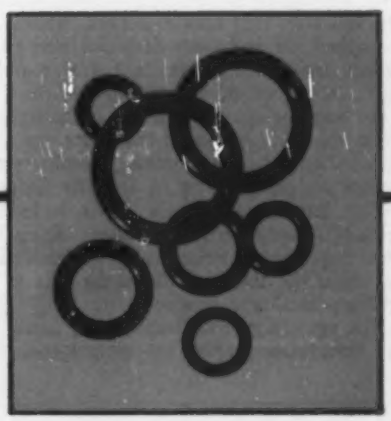

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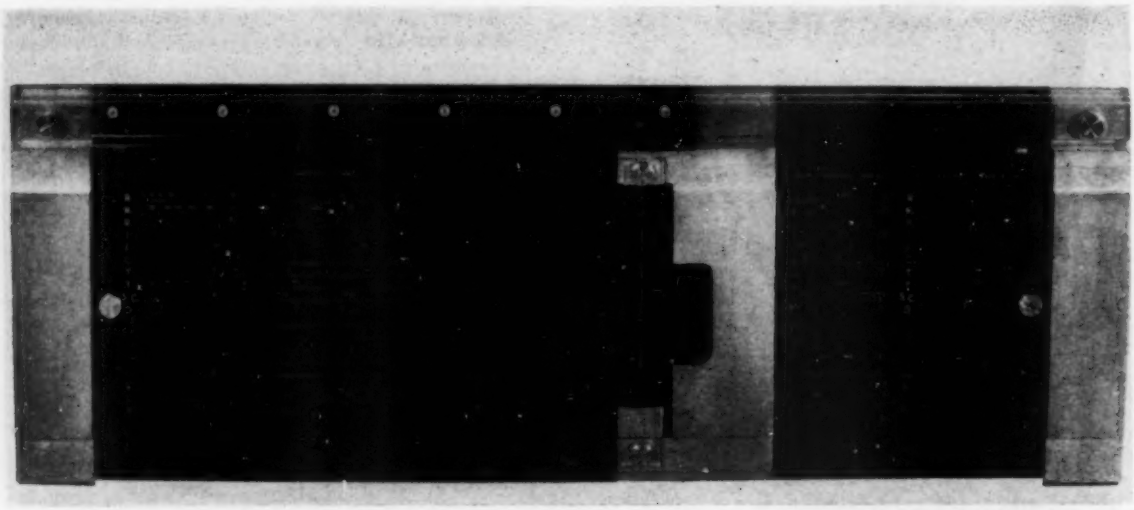


Easy-To-Use, Portable Computer In Slide-Rule Form

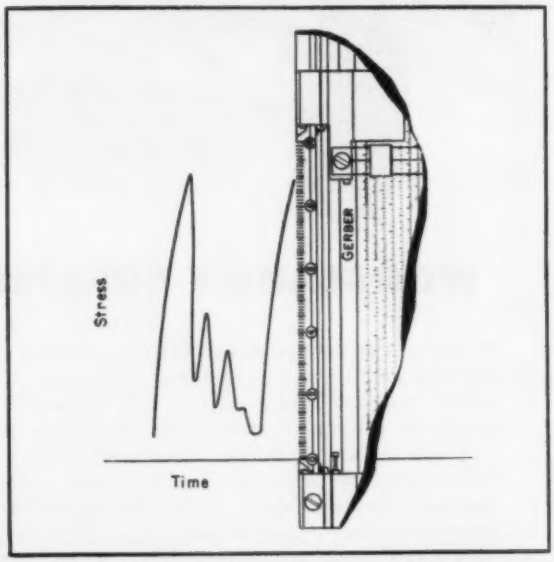
A new instrument in the variable scale family, the GraphAnalogue, will handle linear functions as well as arbitrary nonlinear functions directly, thereby eliminating much of the time normally spent in processing data. It multiplies graphs or curves directly. It divides a distance into any number of equal spaces, or into logarithmically proportional length, or into any arbitrary nonlinear proportion. It is most useful in data reduction where oscillogram recordings can be read directly in the final dimensions, regardless of the shape of the calibration curve.

The heart of the GraphAnalogue is an accurate triangular spring, fixed at the left end, and attached at the right to a slide. Fastened in a similar manner is a round spring carrying little discs with numbers to simplify the reading of the triangular spring.

The triangular spring has 103 coils of which only 100 coils are calibrated. A color scheme is used to subdivide the 100 coils into tens and fives, where every tenth coil is marked red and every fifth coil blue-green. The round spring carries the numbers 0, 2, 4, 6, 8 and 10 to calibrate the 0, 20, 40, 60, 80 and 100 coils of the triangular spring. Since both springs are attached at the right end to a slide, when the slide is moved, both springs extend the same distance and the same numbers calibrate the coils. Both springs are protected by an optically designed crystal.

The instrument has 18 scales including logarithmic, probability, trigonometric, power, linear and reciprocal. Most important however, is the Graph Paper Insert which fits under the side and allows the user to work with any arbitrary nonlinear function.

The purpose of the Graph Paper Insert is to read, plot and interpolate graphs, curves and scales involving nonlinearity. Typical applications are found in reading oscillogram or telemetering curves where a nonlinear calibration curve is necessary; plotting from curves; interpolating between families of curves where linear, or logarithmic interpolations are too inaccurate; reading one set of data directly coverted to another set; and plotting nomograms.



THE PROBLEM is to read a strain gage recording where 1 inch amplitude = 18,730 psi. Also include a correction factor = 0.924. Solution: 1 inch = (18,730)(0.924) = 17,310 psi. Set the hairline to 17.31 on the R_1 scale. Every coil represents 1000 psi. Scale off the stress with the spring.

The GraphAnalogue is about 14 in. long, 5 in. wide and $\frac{1}{2}$ in. thick. It is completely mechanical, and has a built-in dovetail slot to be used on boards or in gangs.

Both the left and right ends are cemented to the base. The main body of the instrument is made of aluminum.

Gerber Scientific Instrument Co., 162 State St., Hartford 3, Conn.

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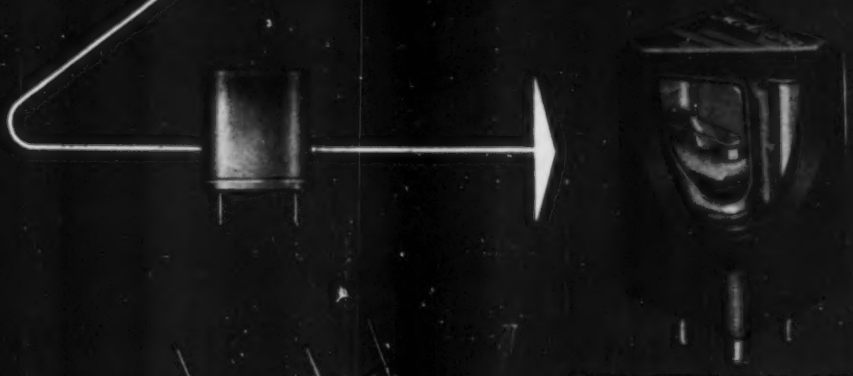
Stevens Type C Thermostats



HERMETICALLY SEALED

STANDARD

If your product requires a high degree of temperature stability . . . if compactness is a *must*—specify Stevens Type C* thermostats. Since contacts open only when bimetal overcomes spring pressure and friction of bimetal against spring surface, electrically independent bimetal responds only to heat from controlled device—*for a clean, positive break.*

Another advantage is that Stevens makes the widest range of bimetal thermostats in the industry. This means that, in most cases, there is a production Stevens thermostat to fit your special requirements to open or close the circuit on any predetermined temperature rise from −75° to 600° F. So consult with Stevens when your product is in the design stage and assure *better performance, longer life.*

STEMCO

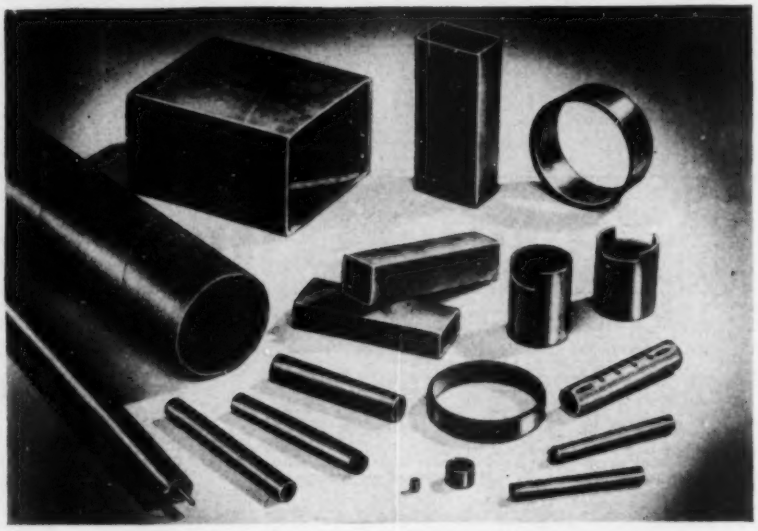
STEVENS

Paper Base Tubing Has Good Dielectric Properties

Resinite tubing with increased wall strength, improved dielectric and other electrical properties, as well as high chemical and moisture resistance, is available in all shapes, widths, and lengths, including round, square, rectangular, and oval. Inner diameters range from 0.125 to 3 in., with wall thicknesses from 0.006 to 0.100 in.

Tubes can be supplied threaded inside or outside, slotted, punched, or embossed. Threaded coil forms have a special three-row design to permit axial pressure in excess of 25 pounds. Torque can be controlled to ±1 in.-oz., eliminating wobble or freezing of cores, permitting accurate, as well as frequent coil adjustment.

Resinite tubes can be slotted to specifications for flyback transformers. Special small I. D. sizes are available for use as screw insulators in relays and transformers where insulation is necessary. Heavy wall tubes have adequate tensile strength for use as shafts in electrical or electronic applications in which metal might produce undesirable inductive effects. Due to their chemical and moisture resistant properties, tubes of the large O. D. size are being used in paint rollers for both water and solvent base paints.



Three grades of tubing are available: punching, embossing, and coil forming. Properties are: Density: 0.302 grams per CC; Power Factor: 0.0312; Dielectric Strength: (short-time) 2600 v. (average at 0.012 wall thickness); Moisture Absorption: 2.86 (average after 72 hrs. at 100 percent relative humidity); Volume Resistivity: 1.2×10^{12} ohm cm. (wall thickness 0.013 in. O. D. 0.280 in.); Coefficient of Thermal Expansion: 1.02×10^{-5}.

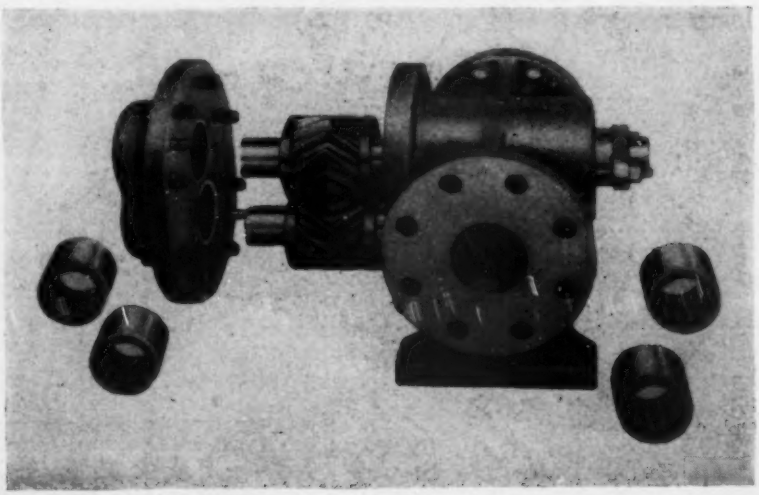
Precision Paper Tube Co., 2035 W. Charleston St., Chicago 47, Ill.

Rotary Gear Pump Has Simplified Design

Developed primarily for positive displacement of lubricating liquids, a new rotary pump of simplified design will handle fluids and semi-fluids, 32 SSU to 250,000 SSU. Capacities with this Hydrex pump are 1-500 gal per minute; 300 psi for continuous duty, and 500 psi for intermittent service.

The simplicity of the pump is featured by: only two castings are used, —for the body and the head; there are only two moving parts—the two rotors; no inner races are needed in the bearings, as the shafts are hardened and ground at the bearings; only one stuffing box is used.

Other specifications of the pump: the rotors are precision made gears: pumps are hydraulically balanced axially; shaft is hardened and ground at the stuffing box, minimizing wear; heavy duty roller bearings are used; all connections over 2 in. are flanged.

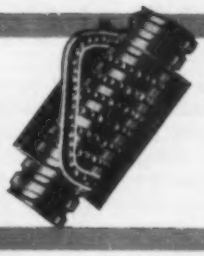


Sier-Bath Pump Co., Inc., 9252 Hudson Blvd., North Bergen, N. J.

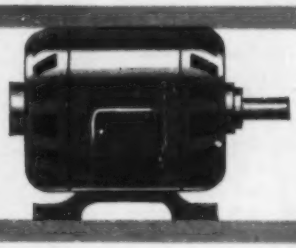
CONTINUED ON PAGE 228

To MOVE with less EFFORT

BALL-SCREW ACTUATORS



REDUCE THIS



TO THIS

If you could take about 80% of the friction out of your moving device, you could vastly reduce the size of motor needed.

Our ball-screw actuator is a combination of the screw (for power) and balls (for friction-free movement).

Many U. S. airplanes have installations of our ball-screw actuators. They have been used to help replace big motors with small ones; to improve control of motion; to eliminate human work required to crank something.

Besides saving weight and reducing the cost of friction—besides providing absolutely smooth motion—besides minimizing need for lubrication—the Ball-Screw Actuator permits the precision control of metal to metal. You can stop on a split micron!

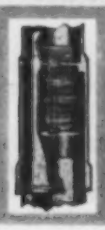
We have expanded our capacity so that we can engineer industrial applications now. Write for booklet describing actuators and their uses.

CLEVELAND PNEUMATIC
TOOL COMPANY
DEPT. E-8 • CLEVELAND 5, OHIO

BALL-SCREW ACTUATORS AIR-OIL SHOCK ABSORBERS
AUTOMOTIVE SHOP EQUIPMENT

To CUSHION SHOCK...

CPT's shock absorber principle combines pneumatic and hydraulic cushioning. It can control minute vibrations or tons of impact. It is the shock absorber for the largest aircraft landing gear (CPT is world's biggest manufacturer of landing gears), but the principle can be adapted to finger-sized units. May we discuss with you how to ease the shock out of stopping or take the motion out of vibration?



WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LANDING GEARS

Metal Cleaning With Ultrasonics

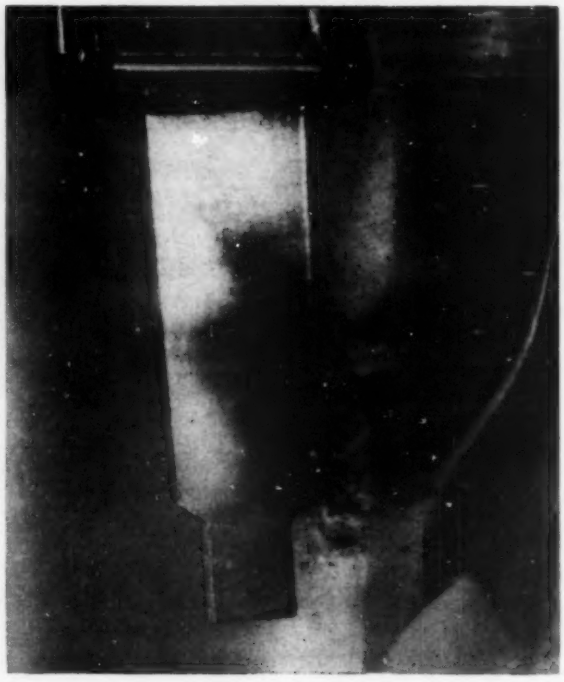
In a new method of cleaning metal by ultrasonics, the main part is the transducer element, which is nothing more than a curved piece of ceramic resembling a 6 in. long pipe, cut in half along the longitudinal axis. The ceramic pieces have focusing and flexibility properties, and can be connected in series and arranged as desired.

With this method, known as the Soniclean process, electrical energy is transmitted to the ceramic transducer, converted into sound energy, and then projected through a solvent at a frequency of 430,000 cycles per second. The solvent being used in the process is trichlorethylene; however, the process is not limited entirely to this material. Because a potential of only 40 volts is required to operate the ceramic transducers, they can be safely immersed directly in the solvent, eliminating the sealed containers.

Material to be cleaned is placed in the solvent, either manually or by conveyor, directly in the path of the greatest focal intensity of the ultrasonic waves. In this area a turbulence is created, resulting in the penetrating cleaning action.

Because of the design of the ceramic transducer, the sound waves converge to a straight line as long as the transducer itself, and is not confined to a single point. In the illustration, dirt on the surface of a jet engine blade is shown as it is being removed by the ultrasonic waves. In this case the substance is an iron oxide paste which is used to coat the blades to help detect possible flows.

Detrex Corp., Detroit 32, Michigan



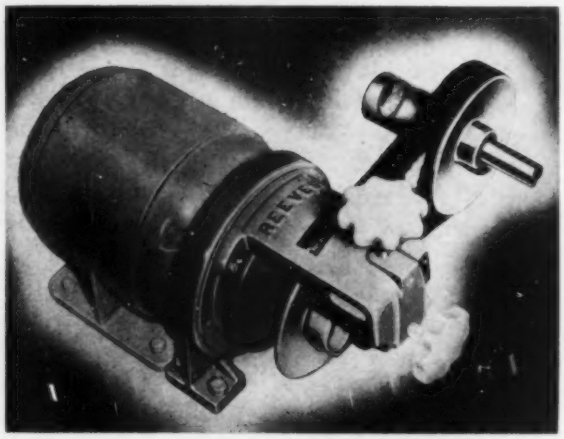
Variable Speed Drive Unit Drives In Any Direction

A new unit in the variable speed drive field combines good flexibility in operation and application with a variety of mounting locations. Called the Flexi-Speed drive, it may be mounted in almost any position around the driven equipment, may drive in any direction, and can deliver any desired speed within a ratio of 8 to 1.

The driven shaft may be located anywhere around the motor shaft, and the speed control hand wheel may be located parallel to, or in any of eight positions perpendicular to the motor shaft. Six different length belts permit a wide choice of shaft center distances.

The units are available in $\frac{1}{2}$, $\frac{3}{4}$, and 1 hp capacities, and are adaptable to most industrial applications, including those with in-line or right angle reducers, countershafts, chain and sprocket, or V-belt drives. It is also used for driving standard gear reducers for parallel drives, or worm gear reducers for right angle drives.

Reeves Pulley Company, Columbus, Indiana



DESIGNED TO HANDLE AIR-PRESSURES from 0 to 250 psi on pneumatic clutches up to 1500 hp, a chatter-proof, quick-release valve has a built-in orifice which prevents accidental removal of the orifice from the line, and eliminates the possibility of pressure equalization responsible for chatter. A double piston design gives quick releasing action. Size is $2\frac{1}{16}$ in. over-all length. Deublin Co., 1155 Waukegan Road, Glenview, Ill.

CONTINUED ON PAGE 230

HOW

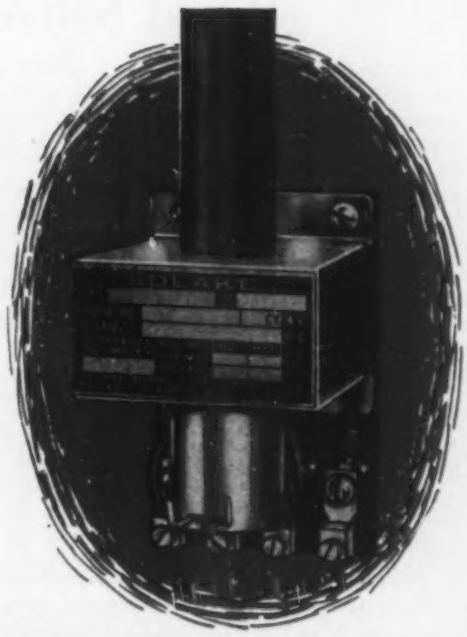
are Adlake Mercury Relays saving money for American Industry?

Today, ADLAKE Relays are increasing efficiency and assuring dependable operation in timing and control circuits in many of the most exacting installations in industry! They are saving money by doing—year in and year out—the jobs that conventional relays can do in an uncertain manner at best!

For instance, ADLAKE Relays have proved their ability to stand up under the most adverse conditions of temperature and moisture. Their time delay characteristics are fixed and non-adjustable . . . normal line voltage fluctuations or ambient temperatures from −38.8° to 200° F. have no material effect on these characteristics.

Yes, in chick incubators or diesel locomotives . . . wherever sensitivity and dependability are required . . . ADLAKE Relays can be counted on. Send for complete Relay catalog today . . . The Adams & Westlake Company, 1169 N. Michigan, Elkhart, Indiana. In Canada, write Powerlite Devices, Ltd., of Toronto.

EVERY ADLAKE RELAY IS TESTED—
AND *GUARANTEED*—TO MEET SPECIFICATIONS!



Type 1040-44 ADLAKE Relay . . . available with time delay or load features and either normally open or normally closed

Adlake 96th year of serving the transportation and building industries

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

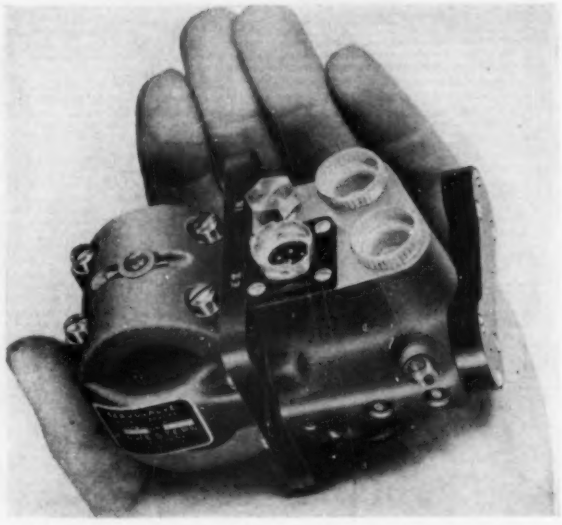
Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

Fast Response Hydraulic Servo Valve

This miniature single-stage, uncompensated servo valve was designed for use in hydraulic servo systems where fast response, reliability, and small size are necessary. Because of its balanced symmetrical twin-position design, it will operate smoothly under adverse vibration and lateral acceleration conditions. The valve has no external leakage, a small drain line returns leakage oil to the sump, and both pistons are accessible for mechanical actuation and may be utilized for safety limit stops in servo systems.

The body and pistons are hardened, precision-lapped alloy steel which insures dependable servo valve operation under dirty oil conditions. This model 4 servo valve may be manifolded directly to the load actuator.

Working Pressure: 200 to 3000 psi; Power to Load (max.): Approximately 5 hp; Steady State Leakage: 0.1 to 0.2 gpm (adjustable); Drain Line Pressure: 15 psi, max.); Torque motor balance current: 20 ma.; Torque motor continuous current (max.): 40 ma.; Hydraulic Lines: AN $\frac{5}{16}$ in. O. D. per AND 10050-5, (may be adapted to $\frac{1}{4}$ in. for low flows); Weight: 2.8 pounds.



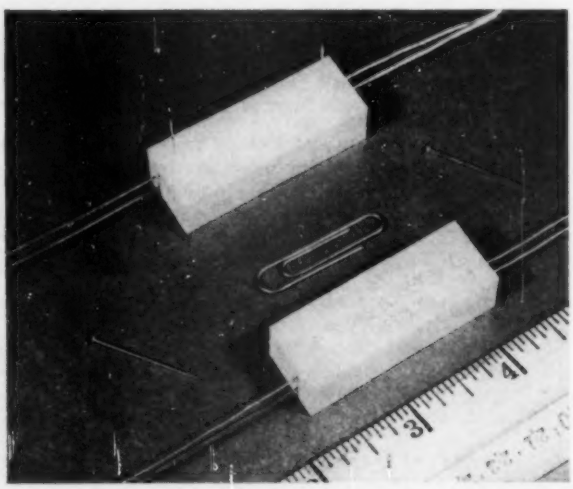
Midwestern Geophysical Lab., 3401 S. Harvard, Tulsa, Okla.

Potted, Sub-Miniature Delay Line

Simplified mounting of this compact, potted, sub-miniature delay line is shown by the two pins that are passed through the delay lines, and the panel on which the line is mounted. A drop of solder is placed on each pin at the back of the mounting panel.

This delay line is of the lumped-constant design, and has a time delay of 2.5 microseconds, or 5 microseconds if a reflection is used, and has an attenuation of 2 db. A number of these lines can be used in series to give any integral multiple of the basic 2.5 microsecond delay. Molded in a thermosetting resin, the line is compact, having dimensions of $1\frac{3}{32}$ x $\frac{11}{16}$ x $\frac{1}{2}$ in., and weighs only 0.68 ounce.

The characteristic impedance is 2800 ohms, and the working voltage is up to 500 volts. The delay line has a rise time of 0.5 microseconds (measured with source and impedances equal to the characteristic impedance). Leads are 22-gage copper wire, tinned, $1\frac{3}{4}$ in. long.



The Jacobs Instrument Co., Bethesda 14, Maryland

A NEW COMPACT, WIRE-WOUND CONTROL has no shaft, but is screwdriver adjusted by means of a slot in the rotor. Of the semi-fixed type, it has resistance values of from 4 to 500 ohms linear only, and a resistance tolerance of ±20 percent. Insulation withstands 500V a-c and the mechanical and electrical rotation is 245 deg. without bias resistor stop. The contact arm is grounded to the case, while the insulated terminal protrudes either parallel to or at right angles to the mounting surface. Clarostat Mfg. Co., Inc., Dover, N. H.

A NEW SOLENOID FEATURES a replaceable coil which can be changed in the field by removing two spring clamps. Available in two models: No. 230 delivers about 6.5 in.-lb. per stroke, and No. 231 delivers 9.5 in.-lb. per stroke. Voltage rating is 50 or 60 cycles, and the field coil is moisture-proofed or oil-proofed. Dormeyer Industries, 3418 N. Milwaukee Ave., Chicago 41, Ill.

CONTINUED ON PAGE 232

building for the future

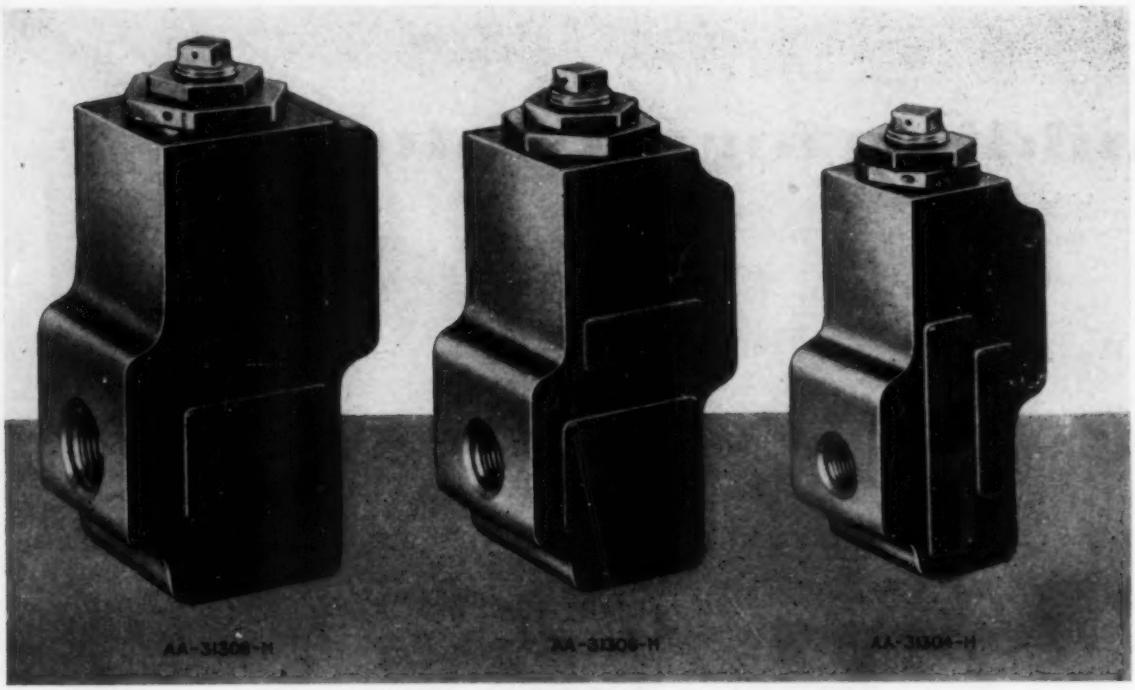
Imaginative architects and engineers know that inhibitions and prejudices must be stifled if creative development is to have full freedom of expression. That's why many seemingly senseless drawing board doodles often emerge as revolutionary ideas in building technology.

We are happy to have had a hand in shaping some of these mental images into metal miracles for today's innovations in the heating, air conditioning, lighting, acoustical, structural and ornamental fields of building construction.

Van Huffel

TUBE CORPORATION · WARREN, OHIO

where ideas take shape for the industries that serve the nation



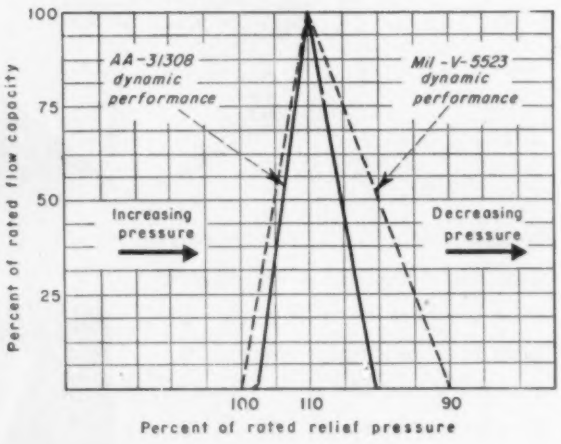
Wide Range, Balanced Piston Relief Valves

The new two-port, balanced piston, relief valves shown here have rated capacities (from left to right), of 9, 5, and 2 gpm respectively, and are greater than required by specification MIL-V-5523 by 6, 3.5 and 1.5 gpm respectively. A 16 gpm size, is also available. The same internal parts also may be used in a four port housing.

The two main features of these valves are: (1) low pressure variation from the cracking point to the maximum rated capacity; and (2) low internal leakage. The operating range is adjustable for 500 to 4500 psi without a parts change. The temperature range of operation is between —65F and 160F.

The basic valves are available with a vent feature which permits control of the valve from an outside source. Another feature is an external drain that will isolate the flow over the valve control ball so that system back pressures will not affect the pressure relief setting.

A central bore in the housing contains all of the working parts of the valve which consist of a sleeve and spool subassembly, a large fixed load spring and a smaller adjustable load spring which retains a control ball on its seat.



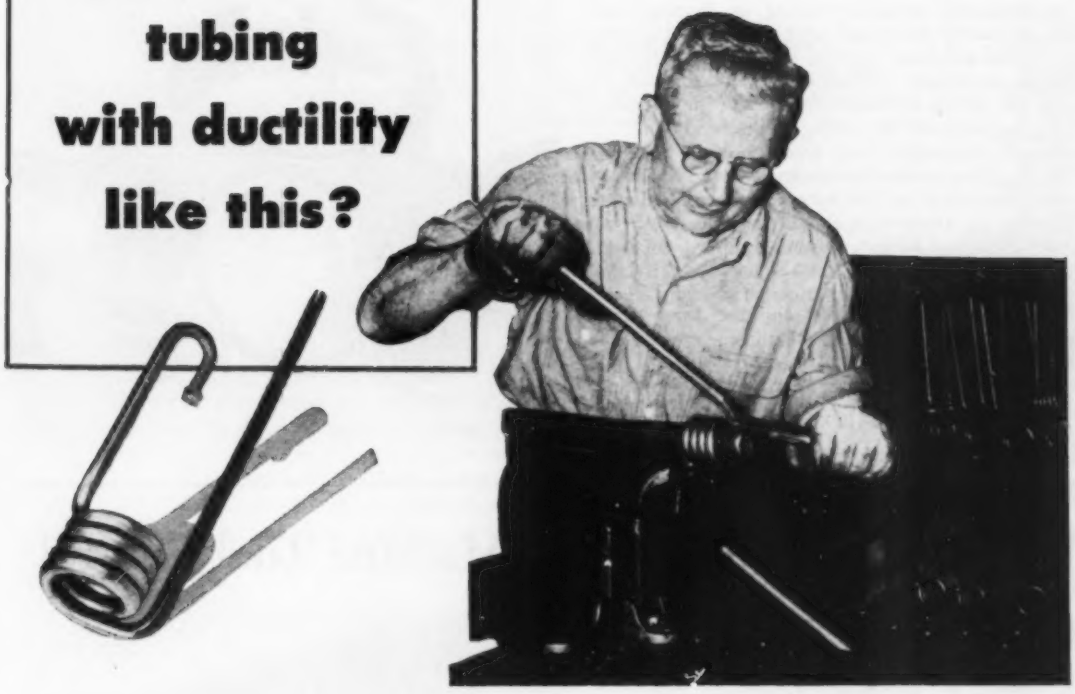
Vickers Inc., 1400 *Oakman Blvd., Detroit* 32, *Mich.*

NEITHER A SIZE 2 NOR A SIZE 3, a new size 2½ magnetic starter and contactor now may be used in place of a size 3 control where the horsepower rating overlaps the size 2. The smaller physical size is also an advantage. These controls are rated 20 hp, at 208-220v; 30 hp at 440-550v, a-c polyphase; and some are available with built-in selector switch. Davis Automatic Controls, Ltd., 4251 Dundas St. West, Toronto 18, Canada.

SYNCHRONOUS MOTORS for light loads are available at speeds from 10 rev. per hour to one rev. per month. Takes continuous loads up to one in.-pound. Vocaline Co. of America, Inc., 209 Coulter St., Old Saybrook, Conn.

CONTINUED ON PAGE 234

Can you use tubing with ductility like this?



● These bends are unusual. For one thing, they're in every possible plane. Also, the radius of each one is short. Much shorter than you'd think possible. And it takes the strength and ductility of ELECTRUNITE Tubing to stand up under this kind of bending.

Does this give you an idea? Maybe you have a problem right now that ELECTRUNITE Tubing might solve. Perhaps you want to cut costs. Or use a different method of fabricating.

Whatever it is, it will pay you to investigate Republic ELECTRUNITE Tubing. It's available in both carbon and stainless analyses. Our engineers will be glad to work with yours to help you use it—profitably. FOR BOOKLET WRITE TO:

STEEL AND TUBES DIVISION
REPUBLIC STEEL CORPORATION
222 EAST 131st STREET • CLEVELAND 8, OHIO

REPUBLIC STEEL

Republic
ELECTRUNITE TUBING

Tube Fittings Attached Without Welding

Corrosion resistant fittings can be attached to rigid tubing mechanically, without welding or brazing, and result in a completely leak-proof joint. The coupling parts are made in non-stabilized stainless steel; mild steel; cadmium plated; aluminum, anodized; or titanium, and are attached to the tubing by means of an expander mandrel which rolls, and expands the tubing to the fitting.

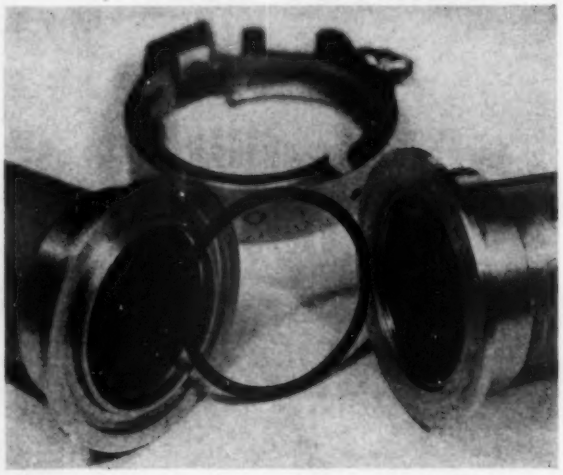
Extremes of temperature and vibration have no effect and all fluids, gases and corrosive agents can be handled if the correct materials for both tube and fittings are used.

The fittings are available with either plain or O-ring groove vee-clamp type flanges, in a size range from ¾ in. to 7 in. O. D. tubing. Tube fittings are also available with 4, 6 and 8 bolthole swivel flanges in the same O. D.

In addition to the above swivel and vee-clamp flange versions, the fitting has also been designed with female swivel nut terminations in ⅜ to 1½ in. O. D. tubing.

Shown is the O-ring groove, vee-clamp type flange fitting.

Avica Corp., Box 1090, *Portsmouth, Rhode Island*



Plunger Potentiometers For Machine Tool Control

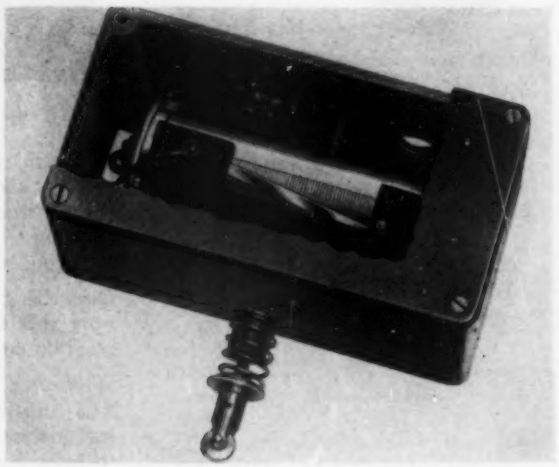
Plunger potentiometers are now available for industrial electronic control applications such as constant cutting speed machine tool drives, winder drives and processing machinery, as well as "dancer roll" systems.

In the case of constant cutting speed machine tool drives, the potentiometer interprets the position of the cutting tool for the electronic control system. When driven by a flat or rotary cam actuated by the cross feed mechanism, the potentiometer may interpret position as a linear or non-linear function, depending on the shape of the cam.

The resistance element and the sliding contact are protected by an oil-tight enclosure. The plunger, with its roller-type cam follower requires only ½ in. linear movement for complete traverse of the 10,000 ohm potentiometer.

A small unit, the model 68 shown measures only 8½ in. in width x 4½ in. in depth x 7⅞ in. high over plunger roller.

Ward Leonard Electric Co.,
115 *Mac Questen Parkway South, Mount Vernon, N. Y.*



A WIDE VARIETY OF miniature and sub-miniature metal tubing for use as component parts of transistors and other electronic equipment can be made in sizes down to 0.010 in. O. D.; walls down to 0.0010 in.; and tolerances as close as 0.00025 in., in metals of almost any analysis. The Pointer tubing, an aluminum alloy tubing, some of it finer than a human hair, is used as the indicating needle in sensitive measuring instruments of all types. The tubing is seamless, cold-drawn, and the maximum O. D. is ⅜ inch. Uniform Tubes, Inc., 1220 Level Road, Collegeville 2, Pa.

IN ADDITION TO HAVING GOOD drying-oil properties, a new primer, P-50, has been specifically formulated for use with active solvent synthetics, and particularly with vinyl coatings, giving in one coat approximately 2 mils of dry film thickness on flat areas, the primer has a good "edge build", and does not draw thin over any irregularities on the surface. The primer has good adhesion properties, will bond to most metals, and may be used over old, corroded, wire-brushed metal. It also may be used over most old paints, whether oil-base, rubber-base, or vinyl. It provides for the control of under film corrosion and rust creepage. Prufcoat Laboratories, 50 East 42nd St., N. Y. 17, N. Y.

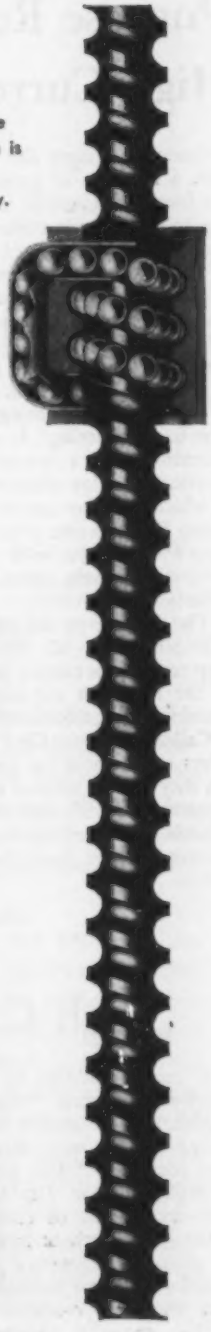
CONTINUED ON PAGE 236

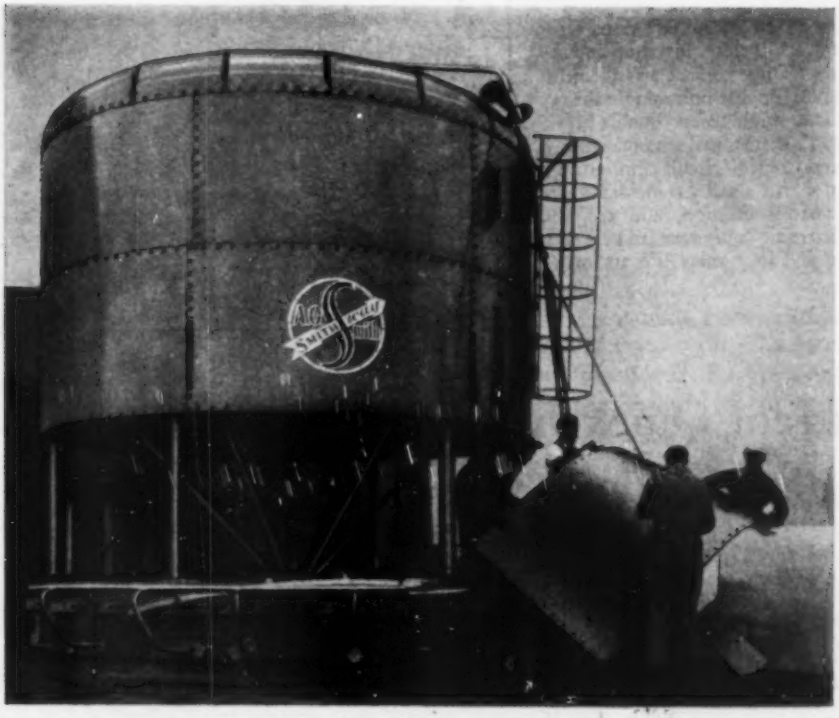
SAGINAW BALL BEARING SCREWS

revolutionize feed storage structure erection

The HARVESTORE Division of the A. O. Smith Corporation of Milwaukee, Wisconsin has come up with a remarkable use for the efficient Saginaw Ball-Bearing Screw. Using five Saginaw screws as jacks, a crew of three men can put up a complete HARVESTORE farm feed storage structure in two days by building from the top down — and up! The top section is assembled first, on ground level. It is then raised in this manner: an air-compressor, powered by a 1½ H.P. engine, drives an endless chain which rotates all five screw-jacks simultaneously. After the top section is raised, the next section is assembled, both sections are then raised — and so on. This method saves considerable time, eliminates scaffolding and banishes the hazards of erecting the usual type of feed storage structure. • In the country's best manual and power steering gears, in machine tools, in many of the latest type army and navy aircraft, Saginaw screws are raising, lowering, pushing or pulling loads up to thousands of pounds with a fraction of the power that would be required by any type of thread-to-thread screw. • With wear reduced to a minimum, there is no appreciable increase in back-lash throughout the life of Saginaw Ball Bearing Screws. They can be effectively combined with electrical, hydraulic or pneumatic units. And they simplify service and reduce maintenance requirements (even to the extent of operating effectively with no lubrication). Saginaw screws can be furnished in any size in a complete range of load and life requirements.

FOR MORE COMPLETE INFORMATION WRITE FOR ENGINEERING DATA BOOK.



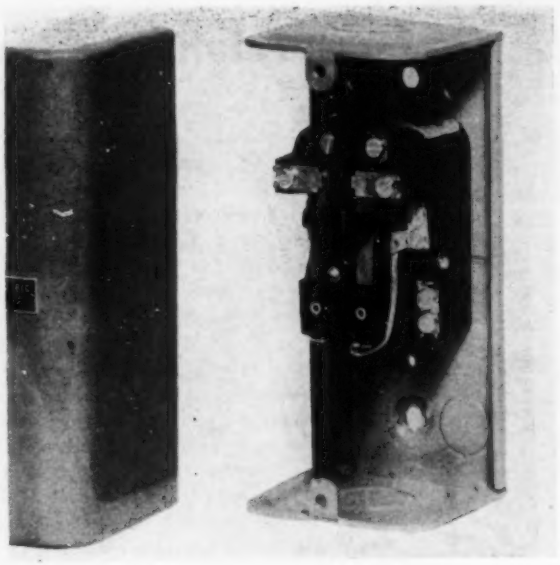


Saginaw STEERING GEAR DIVISION

55

GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN • MANUFACTURER OF SAGINAW POWER STEERING

Long-Life General Purpose Relays, Have High Current Rating



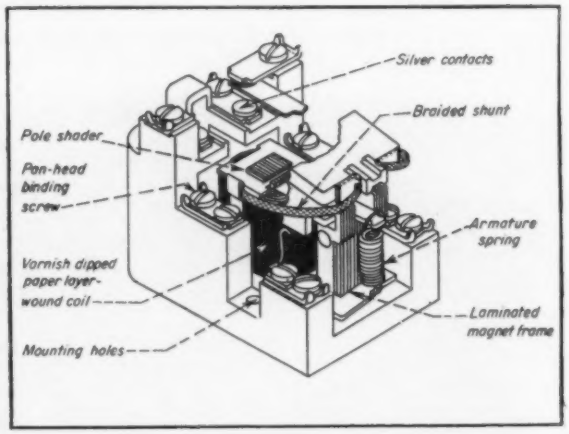
Featuring longer life and greater flexibility of application, a new line of general purpose relays in both a-c and d-c forms are available in voltages up to 300 volts. According to the manufacturers, operating life of the relays has been increased by use of a braided shunt and repositioning of the shunt to reduce tension and wear. For d-c voltages of 250 volts, a unit mounted resistor is included in addition to heavy silver contacts for extra long contact life. Also, added flexibility is offered through a variety of accessories for combinations for any application.

In its standard form, the relay is front connected and is suitable for mounting on either a metal or compound base back mounting. In addition, mounting studs for back mounting, and a special plug-in mount are available as accessories. Also available is a special cast iron enclosure in which the relay may be mounted for dust-tight or class 1, group D, explosion-proof service. Use of the standardized open-form relays with conversion kits, which may be stocked separately, gives units greater utility, and permits reduction in inventory.

The new relays, designated as CR2790-E, are rated from 6 to 300 volts; 60, 50, and 25 cycles plus d-c; and 10 amp continuous contact rating. Three contact arrangements of the new unit are available: double-pole single-throw; double-pole double-throw; and single-throw double-break.

Called the model CR 2790-E, these small general purpose relays are suitable for general control circuit applications, but they may be used as starters for small a-c motors where motors have sufficient overload protection, and are also suitable for application in electronic equipment and air conditioners, where small space and long relay life are major factors.

General Electric Co., Schenectady 5, N. Y.



High Current Quick Disconnecting Connector

A recent addition to the line of quick-disconnecting connectors, the AQRE 12 with twelve large contacts having 0.113 inch diameter solder cups for #12 AWG, permit the use of higher current (up to 25 amps) with no sacrifice of electrical characteristics, and without increase in overall physical dimensions of the comparable QRE-type conector having the same number of contacts.

The specially designed spring-loaded contacts permit easy disengagement of the plug and receptacle. Floating contacts assure proper "play" for self-alignment, and locking guides prevent accidental disconnection due to vibration and serve to polarize mating connector parts.

Contacts and metal parts are gold plated over silver for low contact resistance, prevention of corrosion, and ease of soldering. The bodies are molded melamine to give high dielectric, arc resistance and mechanical strength. The one-piece construction does away with unnecessary creepage paths, and reduces the number of moisture and dust pockets.

Voltage breakdown betwen contacts at sea level is 6250 volts d-c; at 60,000 feet altitude, 1450 volts. Weight of the plug is 1.2 oz.; receptacle, 2.1 ounces.

Also available is a miniature four contact connector, the JF-4, designed for right angle mounting, and suitable for applications in portable and aircraft equipment. Overall dimensions are 1 in. max. height, and $1\frac{1}{16}$ in. engaged length. Total weight of plug and receptacle is 0.04 ounces.

Winchester Electronics Inc., Glenbrook, Conn.

CONTINUED ON PAGE 238

One Sure Way to Get MORE DEFENSE FOR LESS MONEY

How can we get more national defense for less money? The best answer yet given to this question appears in a little-noticed section of the new defense budget. That answer, with which this editorial is concerned, is to provide more equipment with which to step up munitions production in an emergency. Thus we can eliminate much of the need to stockpile finished munitions in advance.

The new defense budget provides an appropriation of $500 million, to be invested by the Secretary of Defense in specialized facilities required to produce munitions on a wartime scale, but not adapted to profitable operation by private industry in normal times. Facilities of this type are known as "stand-by capacity."

There is no strictly political controversy over the "stand-by capacity" program. It was originally suggested by Clay Bedford, Special Assistant to the Secretary of Defense during the Truman administration. It has since been reviewed and endorsed by the Eisenhower administration. Moreover, it involves little or no technical controversy. Civilian and military experts are well agreed that the only alternative to enormous expenditures for stockpiling military equipment is to provide enough facilities for producing it quickly in an emergency.

Here is the Key Idea

In his speech of May 19, introducing his defense budget to Congress and the nation, President Eisenhower stressed the value of such reserve capacity in these terms, ***"The more swiftly and smoothly we can mobilize, the less our dependence upon costly standing armies and navies."***

In accord with this idea, the $500 million requested for the present reserve capacity program would be invested in tools that require a long time to produce, and so present grave complications in an emergency unless they are ready in advance. Some such tools would be installed in new plants that are needed to eliminate potential bottlenecks in the defense production program. Others would be ordered to replace that part of the government's present machine-tool inventory which is made obsolete by changes in the design of defense products. By completely "tooling up" with the most modern equipment, the admin-

istration hopes to realize a production potential many times greater than could be achieved by spending the same amount of money on military end-products.

Examples of Savings

In the specialized field of defense production, adequate modern capacity is the key to both economy and speedy delivery in a pinch. Here are some striking examples from the recent report of the Advisory Committee on Production Equipment (Vance Committee) to the Director of Defense Mobilization:*

—In the case of certain ammunition components, the cost of new capacity can be recovered in only six weeks of full production.

—If $500 million worth of special tools needed to make aircraft are purchased in advance, aircraft production during the first two years of war will be increased about $18 billion. In other words, it costs 1/36 as much to acquire the tools in advance as to acquire the aircraft.

—In the case of a certain ordnance item, an expenditure equal to the cost of only 150 units of the item will provide the capacity to produce thousands and save three years' time in meeting mobilization requirements.

Moreover, reserve plants and equipment can be kept up-to-date at only a small fraction of the cost required to maintain an up-to-date reserve of military end-products. The cost of replacing 5,000 obsolete tanks is at least $1 billion. The cost of new tools for a tank plant would be less than 10% of that amount.

*This Committee, headed by Mr. Harold Vance, President of the Studebaker Corporation, included Clay Bedford, then President of Chase Aircraft, Manly Fleischman, former Defense Production Administrator, and several retired military leaders with wide experience in procurement.

Savings Will Multiply

On the basis of facts like these, the Vance Committee recommended that the Defense Department spend $500 million to $800 million per year on specialized defense production facilities in order to provide substantial reserve capacity as soon as possible. It also recommended that expenditures for military end-products which get obsolete rapidly be held to a minimum. The Eisenhower administration has adopted this approach to the problem of munitions production in asking that $500 million be invested in reserve capacity.

The importance of this approach is much greater than is indicated by the amount of money to be spent on new tools, although this amount will go far toward assuring a healthy machine tool industry, adequate to meet emergency demands. ***What is really important is the great saving that can eventually be made in the cost of our defense program by a modern tooling program.*** If we are to maintain this program for a long period, and if we are to pay as we go, we must have a low-cost program. No other plan to reduce and control the cost of a garrison economy can compare with the new approach suggested in the Vance Report and now embodied in the new defense budget.

Congressmen will do well to scrutinize all military appropriations carefully. They have a chronic tendency to be too big. But there should be no penny-pinching on investments in capital equipment that will pay out in as short a time as six weeks in a war emergency. It would be tragic if this opportunity for real economy were lost in the controversy over other aspects of the defense program. ***The tooling program is a key part of the Eisenhower effort to cut defense costs. It should be promptly approved.***

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The POWER that Builds Reputations

. . . and the Service that keeps them strong

Yes, we *have* a powerful combination—Peerless Premium-Built Electric Motors backed up by Peerless Sales-Service men . . . men who are accustomed to sizing up a job and then acting with conviction and authority . . . men who enjoy the complete confidence of their company because of their ability.

Peerless' customers enjoy the "family feeling" that prevails between company, salesman and customer. In fact, Peerless becomes a part of your company, held there by Peerless knowledge and skill—a relationship made strong by the responsibility and service of our representatives.

Peerless Electric

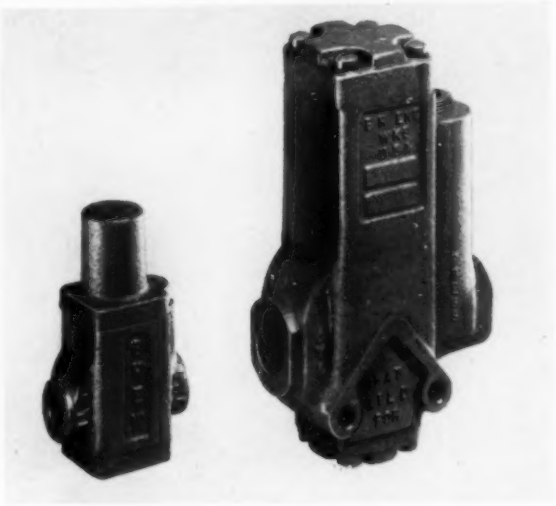
Self-Regulating Flow Valve For Fork Trucks

A new hydraulic flow control valve for fork and straddle trucks is now available in sizes for 2,000 lb. to 30,000 lb. fork trucks, and 45,000 lb. straddle trucks.

The automatic, self-regulating, flow valve controls the lowering speed of a load in inverse proportion to load weight. The heavier the load, the slower it descends. Also of prime importance, particularly when the load is near the rated capacity of the truck, is the positive elimination of surge at the start of lowering.

The pressure in the hoist cylinder actuates the flow valve which allows a predetermined, infinitely variable escapement of fluid from the cylinder resulting in a regulated rate of descent for a given load. There is no restriction of lowering speed for empty hooks or for raising. For example, on one truck in the 3,000 lb. class, for no load it had a 45 ft. per min. descent; for a 1,000 lb. load, a 34 ft. per min. descent; for a 2,000 lb. load, a 25 ft. per min. descent; and for a 3,000 lb. load a 20 ft. per min. descent. All loads between those shown will descend at a rate between those given.

Flow control valves are available for any desired maximum or minimum rate of travel. The manual control of the truck operator is not affected when raising the load or at lowering speeds slower than the flow control valve setting. No additional controls are required because the valve is installed straight-in-line in the high-pressure line from the manual control to the cylinder. When built into



the hoist cylinder base as original equipment, it serves as a safety valve in case of ruptured oil line because the load cannot descend faster than the predetermined speed.

Benton Harbor Engineering Works, Benton Harbor, Michigan

Infinite Control Switch For Wide Range of Heats

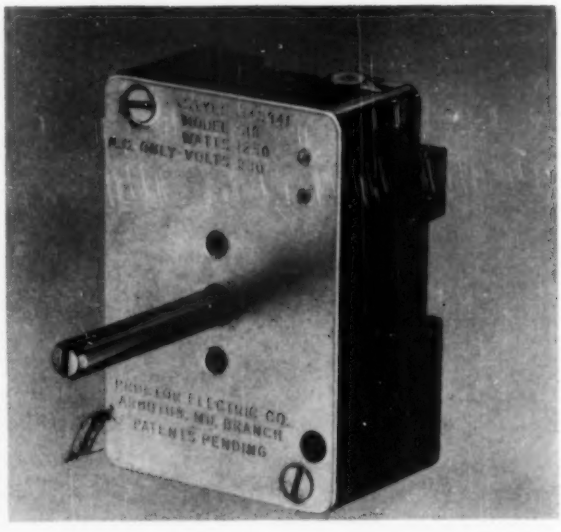
Designed for infinite control throughout the entire range of heating element temperatures, this switch regulates electric heating units through an infinite number of intermediate settings ranging from zero up to the maximum rated wattage. Two models are available: model 510 for 1250 watts; and model 520 for 2100 watts.

Originally designed for electric cooking ranges, the switch can be used with a single coil surface element, or by wiring dual coil systems in parallel. On dual systems a uniform heat can be developed simultaneously in both elements.

The model 510 and 520 switch is voltage compensating in all positions except 100 percent of "high" position. When set, the dial regulates a wide selection of electrical inputs. Ambient temperatures which could affect the control bimetal position are offset by a second bimetal control which adjusts the cam-operated contacts.

A new feature gives a clean make and break of the control thermostat (bimetal timer). The heater for the control bimetal has a low mass and an average thermal coefficient of expansion. This results in rapid expansion and contraction during each cycle of operation. A spring loop couples the heater to the control bimetal, and transmits a force producing contact over-closure and over-opening at a favorable rate.

Measuring 2½ x 1¾ x 1¾ inches, the infinite control switch is housed in heat resistant bakelite with a metal cover. The switch incorporates a bimetal timer assembly



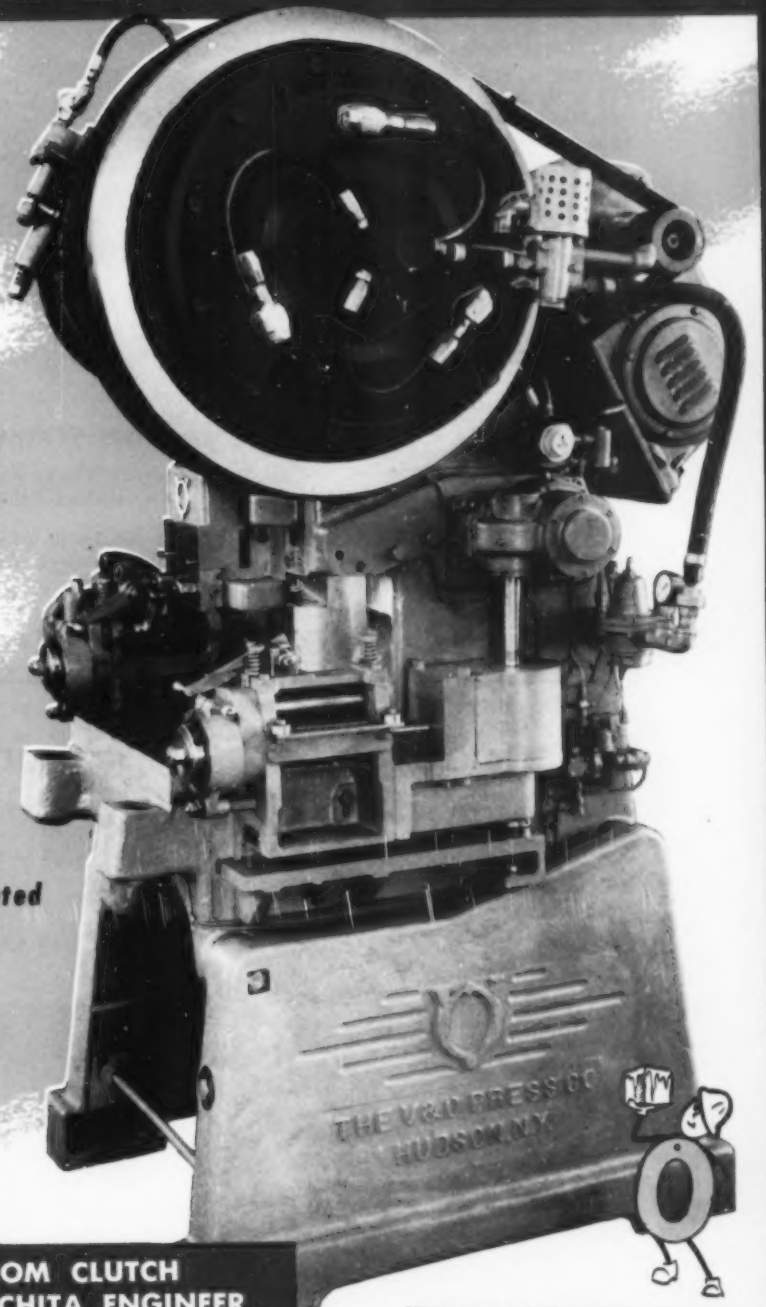
operating on one line, and a disconnect switch on the other line. Current carrying spring members are chrome copper, and silver contacts are used on both line circuits

Proctor Electric Co., 3rd & Hunting Park Ave., Philadelphia, 40, Pa.

CONTINUED ON PAGE 240

Wichita...the Answer to

CLUTCH PROBLEMS for HIGH SPEED OPERATIONS!



To have perfect control on high speed presses operating at 450 Strokes Per Minute, clutches must disengage very quickly, because the elapsed time is extremely short between the ram at the bottom and at the top center. This is a major requirement on 45 ton V & O High Speed Presses. Because Wichita 18" Low Inertia Clutches are the answer to this and many other press clutch problems . . . WICHITA CLUTCHES WERE SELECTED.

In addition, the extremely fast action, of Wichita Clutches and Brakes, is ideal for inching (or jogging) and single stroke operation.

The Wichita Clutch on the press pictured here has been operated in excess of 100 engagements per minute WITHOUT DEVELOPING ANY TROUBLE . . . HEAT INCLUDED!

WICHITA Low Inertia, Positively Ventilated CLUTCHES Will Eliminate:

- **Heat Problems**
- **Adjustment Problems**
- **Lubrication Problems**
- **Centrifugal Force Problems**
- **Self Energization Problems**

TO GAIN MAXIMUM EFFICIENCY FROM CLUTCH OPERATION SEE YOUR NEAREST WICHITA ENGINEER

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WICHITA
WICHITA FALLS, TEXAS, U.S.A.

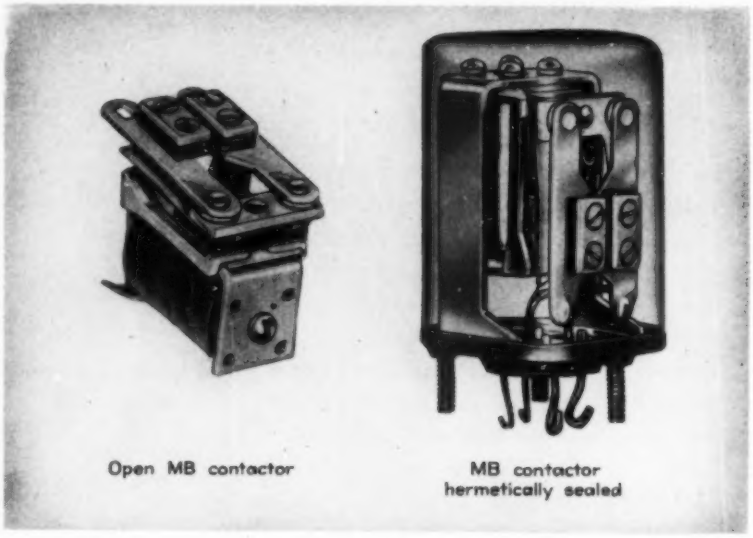
Ad – 15 DH

Miniature, High D-c Power Contactors

Miniature, d-c power contactors, designated as the MB Series, have been developed for very high current applications in aircraft and similar equipment, and are available open ($1\frac{3}{16}$ x $1\frac{5}{8}$ x $1\frac{3}{8}$ in. high) or in hermetically sealed "K" cans ($1\frac{13}{32}$ x $1\frac{5}{8}$ x $2\frac{1}{8}$ in. high).

Open units are equipped with $\frac{1}{4}$ in. pure silver contacts and a solid silver shorting bar rated at 60 amperes, 28 volts d-c, non-inductive load. Contact arms are heavy brass with large, tinned solder terminals. Contact arrangement is 1 Form X (single pole, single throw; normally open; double make).

The pin-hinged armature is equipped with a spring assembly which equalizes a high contact pressure of about 250 grams. MB Series contactors pull in at 75 percent (maximum) of nominal voltage and drop out at 50 percent (maximum). Coils are wound on molded bobbins and varnish-impregnated for protection against moisture. Breakdown voltage is 500 RMS, minimum.



Open MB contactor

MB contactor hermetically sealed

Hermetically sealed MB series contactors are similar in construction to the open type except that they are equipped with Kovar glass, solder terminals rated at 16 amperes, 28 volts, d-c non-inductive load.

Used for high current applications, this unit has rugged mechanical and electrical construction throughout.

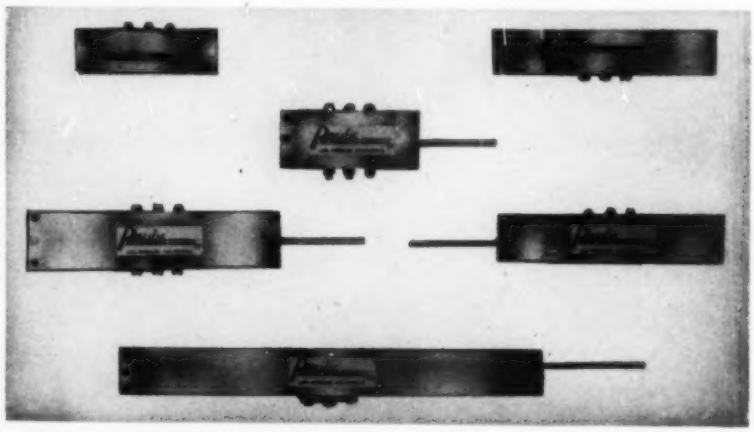
Potter & Brumfield, Princeton, Ind.

End, And Side Actuated Linear Motion Potentiometers

Computers, servos, telemetering devices, and general instrumentation applications are some of the applications of the new series of P1R linear motion potentiometers made for operating ranges from $\frac{1}{2}$ to 12 in. in travel. Capable of high accuracy in rugged service, the units are available as end actuated or side actuated instruments. Backlash in both forms is eliminated.

The potentiometers are available as single or double units. The cross section of the single unit is $\frac{1}{2}$ x 0.783 in., while the cross section of the double unit is $\frac{1}{2}$ x 1 inch. Normally, the linearity is ± 0.6 percent, and a resolution to 0.001 in. is available. They can be used in 250F ambient temperature operation, but special units can be made for 500F operation.

A feature of the design is the full length bearing for the actuator rod and contact block. The potentiometers can be ganged or stacked, and can be supplied with through shafts. The actuator rods are free to turn about their axis. The actuators can be supplied as angular motion actuators.



The potentiometers shown in the illustration have a travel of approximately $1\frac{1}{2}$ to 6 in. in length, with corresponding overall dimensions ranging from $2\frac{1}{2}$ to 8 inches.

Pacific Instruments Co., 2315 Westwood Blvd., Los Angeles 64, Calif.

CONTINUED ON PAGE 242

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Also use this same card when you want additional information on any products advertised in this issue.

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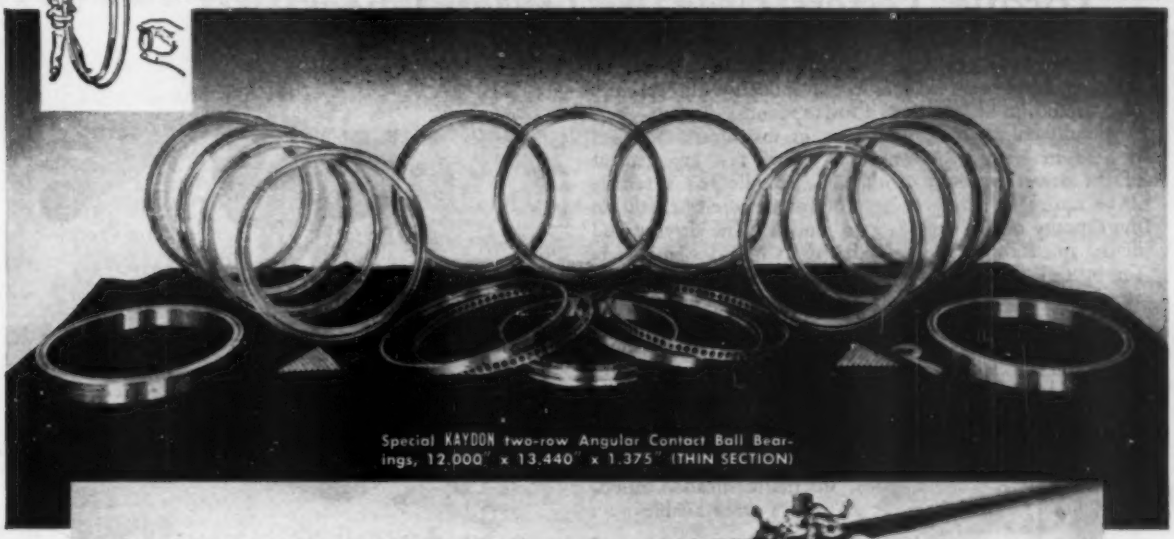
PLEASE USE ONE CARD ONLY . . . so that this service may also be available to other men in your company who may read this same copy of Product Engineering.

To be sure that your request will receive prompt and careful attention, please write or print legibly your name, company affiliation, and address. This service is valuable to you only if you use it. We welcome your comments and suggestions at any time.

Contact KAYDON of Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



Special KAYDON two-row Angular Contact Ball Bearings, 12.000" x 13.440" x 1.375" (THIN SECTION)

These KAYDON-bearinged BELL Anti-Submarine Helicopters won't be outsmarted!

NAVY'S latest "bad news" for unwelcome submarines are the HSL-1 Bell Helicopters . . . most powerful tandem-rotor 'copters known . . . big but compact, with high speed, long range and all-around performance "beyond expectations".

Special thin-section KAYDON two-row angular contact ball bearings, used on the swash plates, contribute much to the compactness, speed, controlability and stability of these modern defenders of America. • KAYDON cooperates with many designers and technicians in terms of precision bearings that improve aircraft, automotive, military and industrial equipment . . . to help make many products better, faster, more profitably.

On units you *make* to *sell*, or *buy* to *use*, specify KAYDON bearings. Contact KAYDON of Muskegon.

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

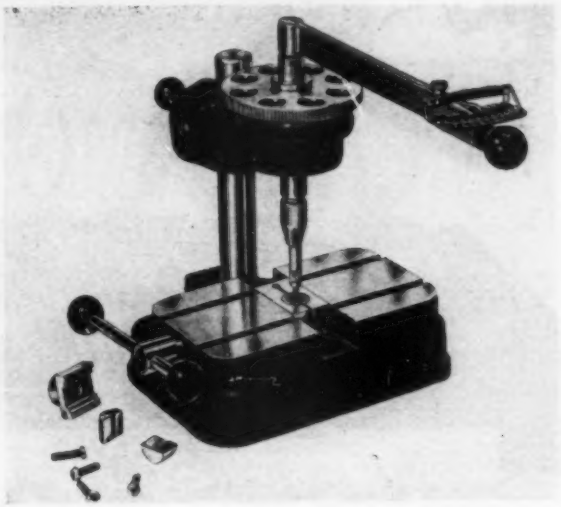
Torque Testers Used As Design Check

Having many practical uses, torque testing devices of the type shown are available in two models with capacities of 0 to 200 in.-lb., and 0 to 150 ft.-pounds.

A fully adjustable spindle set in instrument bearings is held in rigid alignment and allows fast engagement of the driver with the work. The spindle has a female drive square to handle variety of torque wrenches within the capacity of each of the two models. The driving end of the spindle is threaded so that users may design drivers for special applications. A standard male drive square attachment is included with each fixture and is fitted to the driving end of the spindle. This permits the use of regular sockets, socket screw drivers, and others, without alteration.

Illustrated is a typical application of testing the ultimate strength of a screw. This test and others can be used to establish a standard of torque values and the inspection of screws by consumers to determine if they comply with their requirements of standards. Internally threaded collets, collet holder and drivers for all screws are available.

P. A. Sturtevant Co., Addison, Ill



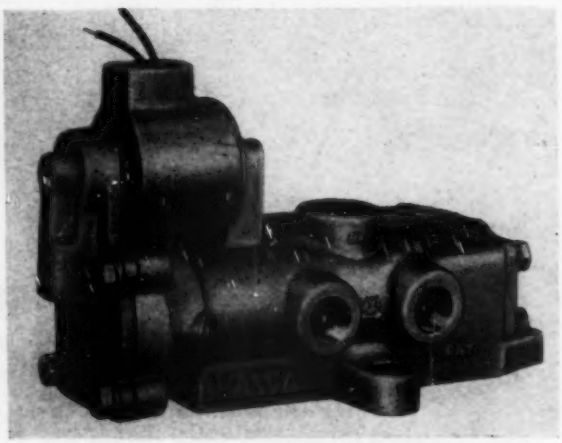
Heavy-Duty, 4-Way Poppet Type Solenoid Valve

This heavy-duty 4-way packless, poppet type solenoid valve, suitable for high-speed machine tool and press applications, will operate up to 750 cycles per min. intermittent duty, and up to 500 cycles per min. continuous duty with air or gas as the medium, and may be used with oil or water.

Many applications are with double-acting pneumatic or hydraulic equipment, and other uses are possible when the 4-way operation is changed into a 5-way operation by changing the rear plate.

In 4 port (common pressure) operation, an optional adjustable flow regulating device permits the operator to control the supply of air, gas or liquid to cylinder No. 2. With this construction, regulated pressure to cylinder No. 2 could furnish the power stroke, while full line pressure to cylinder No. 1 could give a quick return. With 5 port operation, introduction of two separate operating pressures is possible.

Features of the valve, giving it long service and fast operation, are: poppet type, bevelled stainless steel seats and disks; guided, inserted seats; few moving parts; and short stroke. Pressure return of the pilot core eliminates sticking due to residual magnetism or possible binding. The valve can be mounted in any position, and connections can be made to the front, rear, and top, or may be brought into the bottom for pad (manifold) type mounting.



Four sizes are available: $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in. connection, each capable of being converted from 4-way to 5-way use.

The Automatic Switch Co., 391 *Lakeside Ave., Orange, N. J.*

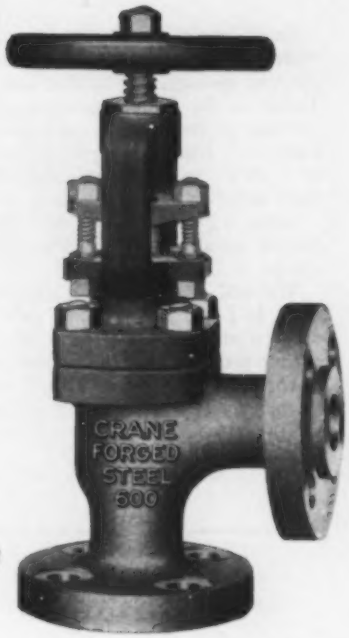
STAINLESS STEEL WIRE THREAD INSERTS are now available in 47 standard sizes—five in the automotive spark plug series, 17 in the national and unified coarse thread series, six in the national pipe thread series, 15 in the national and unified five thread series, and four in aviation spark plug series. Applications are in aluminum, magnesium, iron, steel, brass, bronze, wood, and plastics, and in maintenance, with non-standard thread sizes and lengths supplied for special applications. Heli-Coil Corp., 1330 Shelter Rock Lane, Danbury, Conn.

CONTINUED ON PAGE 244

Best book on the subject of piping ...your handy CRANE Catalog

Your Crane Catalog is far more than an index to the world's most complete selection of quality piping materials—it's a complete designer's reference. For each item shown, Crane lists sizes and dimensions, tabulated pressure and temperature ratings, design, material and construction details—plus a run-down of recommended services. This information is conveniently arranged to save you time. Here, too, is an abundance of general engineering information.

And when your product is Crane equipped, you give its buyers the added value of recognized quality piping.



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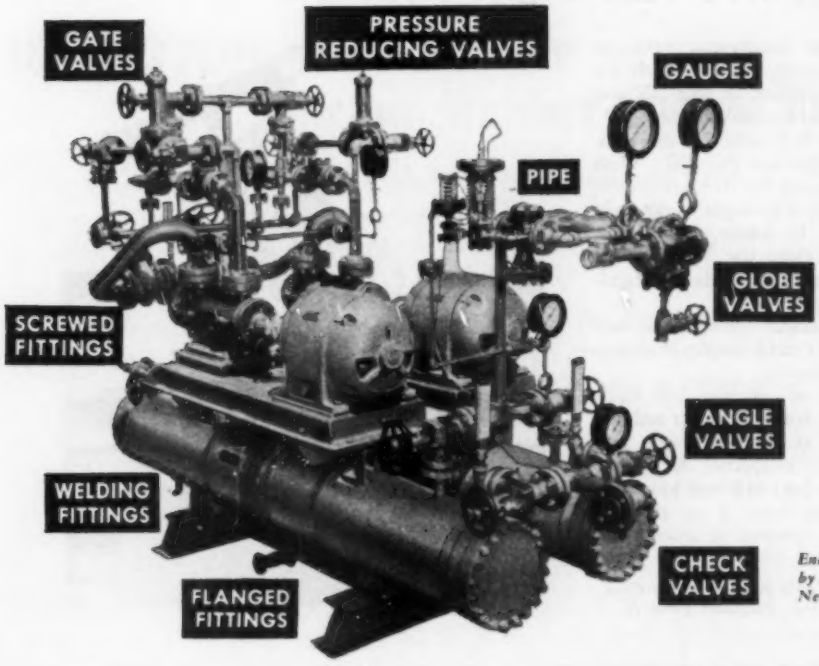
...THE COMPLETE CRANE PIPING LINE



FOR GENERAL UTILITY

in high pressure/temperature service, on oil, oil vapor, steam, water, air or gas lines . . . Crane recommends 600-Pound Forged Steel Globe and Angle Valves, O.S.&Y.—Exelloy or Hardened Stainless Steel trimmed. The line includes union bonnet valves with screwed ends in sizes ¼ to ¾-inch or socket-welding ends in sizes ¼ and ⅜-inch; and bolted bonnet valves with screwed, socket welding, or flanged ends in sizes ½ to 2-inch.

Enco Fuel Oil Pumping and Heating Set by the Engineer Company New York, N. Y.

The Complete Crane Line Meets All Your Valve Needs. That's Why—
More Crane Valves Are Used Than Any Other Make!

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VALVES • FITTINGS • PIPE • PLUMBING • HEATING

All-Purpose Mechanical Seal For Rotary Shaft

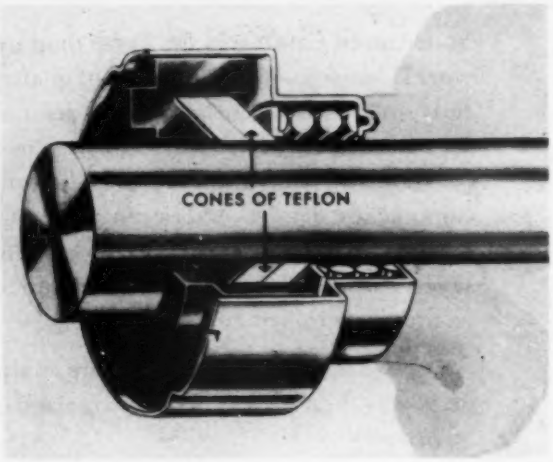
Small pumps, hot water circulators, and other rotary shaft applications are some of the applications of an all-purpose mechanical seal that uses beveled cones made of Teflon as the flexible member. This adapts the seal for life-time performance in small pumps for services involving water, oil, corrosives or acids; temperatures from —100 to +450F; vacuums, and pressures to 200 psi; and high shaft speeds.

Being a packaged type unit, this type 19 seal can be quickly installed for production assembly and replacement service.

The seal is available in sizes to fit shaft diameters of $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$ and $\frac{3}{4}$ inch. The material of the seal, bronze, stainless steel, or others, can be specified to meet service requirements or operating conditions.

For further information and engineering data on this mechanical seal, write to the manufacturer.

Crane Packing Co., 1800 *Cuyler Ave., Chicago* 13, *Ill.*



Diaphragm Valve Has Tight Shut-Off

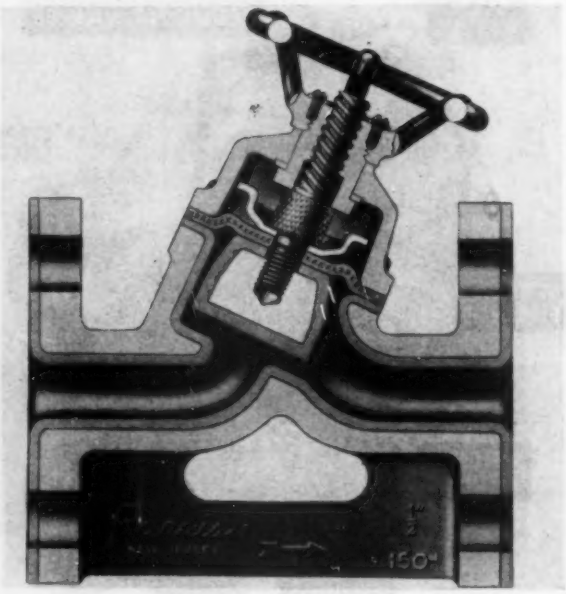
A further development of the diaphragm principle valves has resulted in the X-V series, valves which are primarily designed for such applications as shut-off, and control of acids, chemicals, and other corrosive fluids.

Principal design feature of the X-V series is the individual functioning of the diaphragm and the disk. With this, sealing the mechanism and seating the disk are accomplished separately. As a result, the diaphragm is not subjected to seat wear and abrasion. In severe applications, this design makes it possible to close the valve if the diaphragm fails. Corrosion resistant union ends are standard with some models of this series.

The disk is constructed with ample covering surface material for closure over fine grits, and ample thickness for long life and minimum maintenance.

The valves are made with bodies of cast iron, 316 stainless steel or Hastelloy C. They are available either unlined or lined with the same material as the diaphragm and disk. Diaphragms are of rubber, neoprene, Kel-F, or Buna-N; disks are of rubber, neoprene, 316 stainless steel, Kel-F or Hastelloy C. Sizes range from $\frac{1}{2}$ in. through 4 inches. Connections are flanged, screwed or union.

Farris Flexible Valve Corp.,
705 *Commercial Ave., Palisades Park, N. J.*



SPIRAL BACK-UP RINGS made from Teflon are available with the conventional Z gap with a square cut, and with the ends scarfed at a 30 deg. angle and the Z gap reduced. The new design takes into consideration the actual piston groove diameter and the rod diameter of the units. With the Z gap reduced, better protection is given the O-ring and possible misalignment avoided. Reid Enterprises, 2363 E. 38 St., Los Angeles, Calif.

HYDRAULIC HOSE ASSEMBLIES with high strength Compar tube and a fibre-braid covering are available in $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$ in. I.D., with burst pressures of 9200, 8200, and 7200 psi. Resistoflex Corp., Belleville 9, N. J.

CONTINUED ON PAGE 246

IRVINGTON extra-flexible Silicone Rubber-Coated Fiberglas* Tubing

The extreme flexibility of Irvington's Silicone *Rubber*-Coated Fiberglas—at both high and low temperatures—was an important factor in its acceptance by the electrical industry when this new Class "H" insulation was introduced almost two years ago.

Originally, Irvington Silicone *Rubber*-Coated Fiberglas Tubing was supplied only in white. Because of its rapidly growing use, Irvington has now taken steps to supply this tubing in a range of *colors* also—subject to minimum order requirements.

Immediate delivery can be made on white tubing for wire sizes from #24 to #0—prices and deliveries will be quoted on request on colored tubing.

For preliminary technical data, just mail the coupon below.

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for Insulation Leadership
INSULATING VARNISHES
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Precision Special Purpose Motors

Shown above is a line of special purpose d-c and a-c motors for velocity servo, position servo, and actuator applications. They are available in ratings from 1/100 to 1 hp with clutch brake, and control tachometer.

At the bottom is the d-c tach servo motor DM-51 rated 6 oz/in., 60 to 15,000 rpm, tachometer output 1V/100 rpm, clutch rating 3 in.-lb/min. The brake holding ability is 5 in.-lb/min. Length is 6 in. and dia 3½ inches. Design features include new magnet and commutator arrangements in order to insure a linear output.

In the center is Dm-80 actuator motor (reversible) with an input of 28 v d-c at 1.4 amp, and rated at 5 lb/in. at 10,000 rpm, with a brake holding ability of 11.5 in.-lb/min, and a clutch rating of 10 in.-lb/minute.

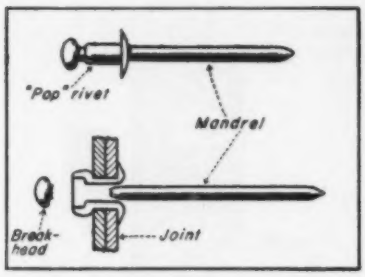
At the top is the DM-81 actuator motor (reversible) with an input of 28 v d-c at 8 amps. It is rated at 0.4 lb/in. at 10,000 rpm, with a brake holding ability of 0.4 in.-lb-/minute. Length is 3½ in. and dia is 2 inches.

Bill Jack Scientific Instrument Co., Solana Beach, Calif.

New Type Rivet Easily Installed

A rivet that can be driven without a dolly, and makes blind spots easy to handle, can be driven at the rate of 1,200 an hour. Known as the Pop rivet, it is available in sizes from $\frac{1}{8}$ in. up to $\frac{3}{16}$ in. dia., and in lengths from 0.190 in. to 0.750 inch, and in Monel and aluminum.

This fastener consists of the rivet itself, and an inserted mandrel of high



strength steel. The mandrel, which resembles a finishing nail, with the attached rivet, is slipped either into predrilled holes in the work to be fastened, or into the fastening tool and then into the hole.

In operation, the collet of the tool grips the shank of the mandrel and pulls while the nose of the tool presses against the head of the rivet and holds it against the face of the section to be fastened. Simultaneously, the collet pulls the shank of the mandrel, expanding the inside end of the rivet to fasten it against the inside surface of the work. This action draws the section of the work together and clinch them in position. The mandrel is so designed that the head will break when the expansion has reached a point sufficient to provide maximum holding powers. The head then falls off and the shank is pulled through the rivet. If necessary, the mandrel head may be retained in the end of the rivet, though the use of the break stem type of mandrel.

J. C. Rhodes & Co., Div. of United Shoe Machinery Corp., New Bedford, Mass.

Adjustable-Speed Drive For Low Horsepower Applications

Developed for adjustable speeds in the lower horsepower ranges, this electronic-type variable speed drive unit is available in ratings of $\frac{3}{4}$, 1, $1\frac{1}{2}$, 2, and 3 hp, and operates at speeds of from 270 to 2,300 rpm or as low as 75 rpm for setting-up operations, light loads, or intermittent duty. Its components are a drive motor, the operators control station, and the control unit.

Some applications are sheet-fed printing presses; paper and packaging machinery; and textile-processing machinery. Special types of enclosures and mountings are available, and optional equipment includes: foot-pedal operation for starting, stopping, and speed control; explosion-proof, for use in hazardous atmospheres; and a

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To serve this great industry a manufacturer must maintain the best and most modern equipment available, operate it with skilled craftsmen, and use every existing method of tightening specifications and cutting production costs. Indiana Gear is such a manufacturer—a company of craftsmen producing fine quality transmissions and actuators for industry.
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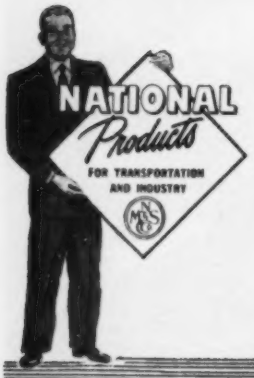

Products bearing these familiar trademarks have all established enviable reputations for quality and dependability. And to guard product reputations, these manufacturers *continue* to specify castings by National —one of the Nation's largest founders.

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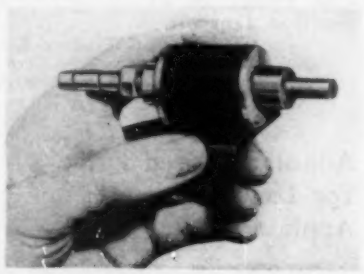
reversing drum-switch which gives forward and reverse operation with speed control.

Other optional units available with the drive are gearmotors in single, double, and triple reductions for lower than standard operating ranges.

Reliance Electric & Engineering Co., 1088 *Ivanhoe Rd., Cleveland* 10, *Ohio*

Small Air Cylinder Has High Thrust

Used in small jigs and fixtures where size and space are limited, this midget sized air cylinder has only a one inch stroke and delivers 75 lb thrust on a 100 lb line pressure. Equal ram pressure is given at any stroke



point on the one inch stroke. The cylinders are made of brass, and any number, from one to several hundred, can be operated by a single control valve.

Applications include: ejection or injection of work; and holding or clamping of parts for welding, riveting, drilling, or bolting.

Air Mite Co., 2651 *West Lake St., Chicago* 12, *Ill.*

Plastic Filter Resistant to All Acids

Now available in disks up to 12 in. in dia. and thicknesses of $\frac{1}{16}$ and $\frac{1}{8}$

in., pure, porous Kel-F is being used as a new filtration medium. It is completely resistant to all strong acids, caustics, oxidizing, agents and common organic solvents, including fuming Nitric acid, Hydroflouric acid, concentrated Sulfuric acid, Hydrochloric acid, and strong caustics.

It may be used at temperatures up to 300 F., and has an ultimate tensile strength of 900 psi. Flow capacities range downward from 500 cfm of air per sq. ft. of filter surface at 8 psi differential pressure, and from 110 gpm of water per sq. ft. at 10 psi differential pressure.

Porous Plastic Filter Co., 30 Sea Cliff Ave., Glen Cove, N. Y.

Quartz Crystals With Varied Characteristics

Stabilized quartz crystals with a varied range of low frequencies and flexible characteristics, are available with gold or silver plated crystals in two models in hermetically sealed glass holders.

The G-9J has a frequency range

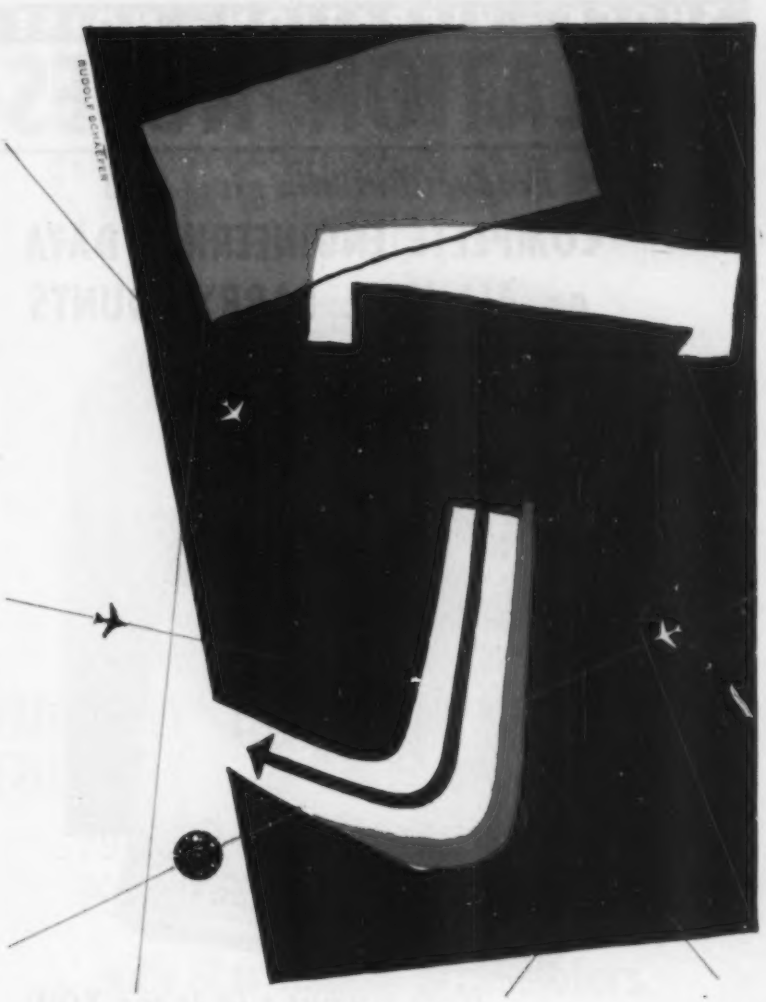
from 1.2 to 10 kc, a frequency tolerance of ± 0.03 percent at —40 to +70 C, and a capacity ratio of approximately 200.

Model G-9 with a frequency range of 5 to 200 kc has a frequency tolerance of 0.02 percent or better at —40 to +70 C. The capacity ratio ranges from approximately 1,000 to 200.

James Knights Co., Sandwich, Ill.

Ball Bearing Bushing For Limited Space

For applications where space is limited, the ball bearing bushing type DR-L (double row-light) features a split outer race which permits introduction of a full complement of balls,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The accurate measurement of pressures is basic in many of our aircraft instruments and controls. Our expanded activities now cover the four distinct yet allied fields of
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4. Curves showing effect of high and low temperature on isolator performance.
5. Shock-characteristic data, including curves showing vibration isolation after 15g shock test.
6. Application data, including curves that show you how to choose isolators for unsymmetrical loads.
7. Dimensioned drawings of unit isolators, channel pairs, and mounting bases.
8. Detailed data on the construction, operating principle, and weights of mounts and bases.
9. A complete list of load ratings and catalog numbers for unit isolators, channel pairs, and bases.

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and has a section height of only 0.250 inch.

Prelubricated, these bearings will give extended service without need of regreasing. The outer race is ground to close tolerance for a press fit, and and the bore is available in two types adapted to either press or slip fitting. Both types will carry thrust, and radial load.

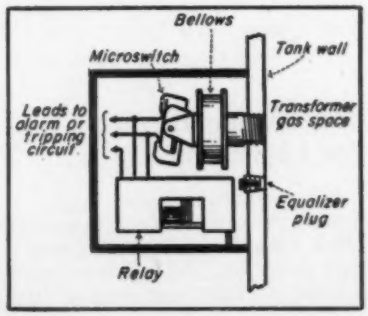
Applications include: sheaves; idlers; oscillating motions; fulcrums; cams; and all types of moderate speed shafts.

Split Ballbearing Corp., Lebanon, N. H.

Sudden Pressure Relay For Power Transformer Protection

Operating on rate of change of pressure, a new sudden pressure relay that protects power transformers from internal faults is not affected by pressure changes common to transformer operation. In addition, it is said to be more sensitive to small faults, and is quicker to operate when large faults occur.

When an arc breaks down transformer oil, the increased gas pressure is transmitted from the transformer case to the relay device through a small tube. The pressure differential is throttled through the tube and actuates a bellows that is sensitive to a



rate of rise of pressure as low as approximately one ounce per square inch per second.

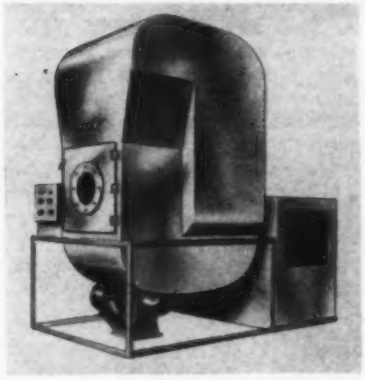
A miniature precision switch connected to the bellows will either sound an alarm or trip a breaker to take the transformer out of service. A manually-operated momentary "off" switch is used to reset the relay.

Faults that reduce rate of rise of pressure of 10 to 15 pounds per square inch per second cause the relay to operate in two or three cycles. Rates of 40 psi per second cause operation within ½ cycle.

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Sand and Dust Environmental Tester

A new design in sand and dust environmental testing apparatus has resulted in a unit having a streamlined air flow, lowering the power necessary to develop the air pressure. At the same time, it reduced the floor



space required and minimized the air pressure drop. The unit was particularly designed to meet specifications MIL-E- 5272A and MIL-T- 5422A.

An additional feature is the automatic temperature and dust density control, permitting long term runs without manual regulation. Air velocity is constantly maintained, and humidity control is also provided.

American Research Corp., Bristol, Conn.

Sub-Miniature, Hermetically Sealed Relay

Having such features as its subminiature size, light weight, long life, and resistance to vibration and continued operation under high accelerations, this DPDT sealed relay is ob-

STOP FAST FAST STOP FAST FAST STOP
START SMOOTHLY SMOOTHLY START

FREQUENTLY FREQUENTLY REVERSE FREQUENTLY FREQUENTLY
POSITIVELY POSITIVELY HOLD POSITIVELY POSITIVELY

with Star-Kimble Brakemotors

Motor *and* connected load come to a split-second stop—because of the extra-large brakelining area of a Star-Kimble Brakemotor.

Motor starts smoothly—without drag—because small air gap assures instantaneous brake release.

No plugging needed for rapid, repeated reversals. Frequency of reversals can often be *tripled*, compared with conventional plugging methods. And loads are held positively by the brake that holds its grip through millions of cycles—with little or no adjustment.

Every Star-Kimble Brakemotor is an integral, space-saving unit with a sturdy shaft that's common to motor and brake. Bearings and brakelinings last longer. One manufacturer—one responsibility.

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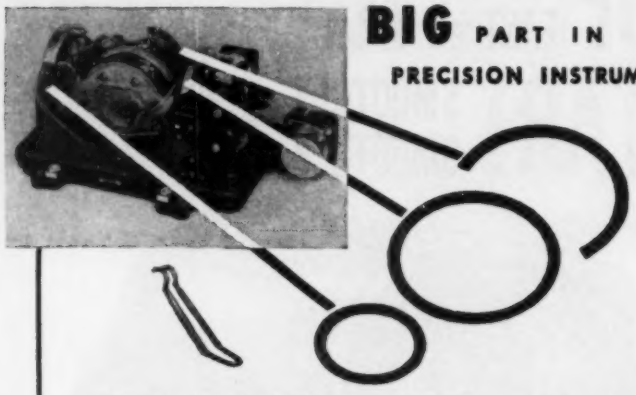

This Cageable Vertical Gyro, for use in stabilization and control systems of aircraft, guided missiles and radar scanners, manufactured by the Aeronautical Division of the Minneapolis-Honeywell Regulator Co., contains three doughnut potentiometers wound with NEY-ORO G high strength, precious metal resistance wire, contacted with wiper brushes of Paliney #7* (illustrated at far left).

Many other manufacturers of precision instruments specify Ney precious metal component parts for use as slip rings, brushes, wipers, commutator segments, etc. Ney Precious Metal Alloys have specific qualities which mean greater accuracy, longer life and resistance to most corrosive industrial atmospheres.

Call or write the Ney Engineering Department for assistance with your instrument problems.

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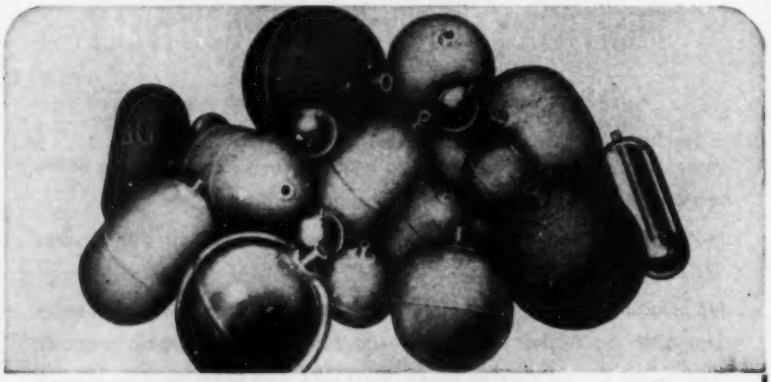

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The booklet is a standard reference for specifiers of welded floats. Nicholson furnishes any type for external or internal pressures; in stainless steel, Monel, chromium, cadmium or copper-plated steel. Sizes, 2" to 14" diam., press. to 4300 lbs.; standard or special connections. Quick delivery on many sizes and shapes. Nicholson floats are standard with hundreds of manufacturers.

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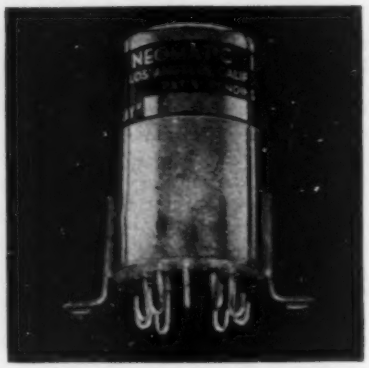

tainable in the range of 50 to 1,000 cycles, operating on an input of 115 volts. Two models are available, depending on contact rating. Model 10220 has a contact rating of 1 amp, non-inductive; model 10320 has a contact rating of 4 amps, non inductive.

All units are hermetically sealed with dry air or inert gas to withstand environmental conditions. Optimum operation is in the temperature range of —55 C to 85 C. Weight: 1.51 oz. (43 grams); dia. 1.00 in.; length 1.71 in. The relay connects with 9-hook or 9-pin header. Vibration characteristics: withstands 20Gs at 300 cycles, contacts normally closed, unenergized, Acceleration characteristics: withstands steady-state acceleration up to 50Gs.

The a-c relay is suited to aircraft applications, but may be used for remote control mechanisms in most military or industrial applications.

Neomatic, Inc., 9010 *Bellanca Ave., Los Angeles* 45, *Calif.*

Shock Absorbing All Purpose Fitting

Used in fuel and oil line applications, the new Sealastic all-purpose, fitting for metal tubing and piping has been adapted for use with water, air, refrigerant, under a range of temperature and pressure conditions.

Eliminating any metal to metal contact, the fitting is made of a compression nut, housing a synthetic rubber seal fixed to the tube by a metal ferrule. No flaring of the tubing is necessary for the fitting.

A self-locking ferrule may be used for pressures up to 1,000 psi, but a fixed ferrule is recommended for critical applications. Fittings will withstand presures up to 4,000 psi and temperatures from —70 to +400 F. The fittings will handle tubes measuring from $\frac{1}{8}$ to $1\frac{1}{2}$ inches O.D.

Chicago Forging & Mfg. Co., 200 *Southport Ave., Chicago* 14, *Ill.*

These Kodagraph Autopositive Intermediates

Protect vital drawings

You're looking behind the scenes at the American Locomotive Company, Ordnance Division, Schenectady, New York.

The prints you see streaming from the processing machine are positive photographic reproductions of M47 tank drawings. They're produced without a negative step . . . and under ordinary room light.

This fast, low-cost operation enables the Ordnance Division to protect thousands of M47 drawings against expensive wear and tear. For the drawings are filed away after the Autopositives are made. Then, because the engineering department of the Ordnance Division holds the design contract for the M47, these highly legible and durable intermediates are used to produce all the quantity prints required by the 29 manufacturers and government agencies involved in the distribution of engineering changes on the M47 tank.

Produce better prints

These Kodagraph Autopositive intermediates, used in place of the valuable original drawings, produce sharp, legible blueprints or direct-process prints time after time. Their dense photographic black lines—on an evenly translucent paper base—will not smear or lose density . . . which simplifies print production and eliminates reading errors and bottlenecks all along the line. *And another important point*—Autopositives are photo-lasting in the files . . . will not turn yellow or become brittle.

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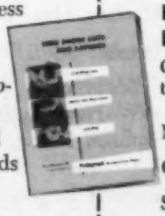

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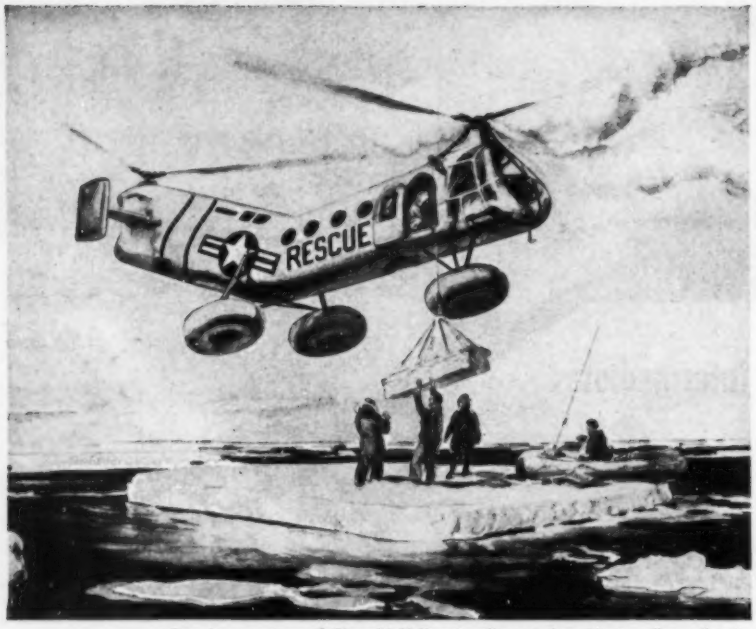

Drawing courtesy of Piasecki Helicopter Corporation, Morton, Pennsylvania

THE H-21 Piasecki Tandem Helicopter—the "Work Horse"—is ideally suited for rescue work in areas inaccessible by other means, and in all kinds of rough weather.

For durable paint adhesion and high corrosion-resistance aluminum parts of the "Work Horse" are Alodized. The "Alodine" protective coating chemical bonds paint, extends paint life, and protects unpainted aluminum.

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MEETINGS

August 19-21

WESTERN ELECTRONIC SHOW AND CONVENTION—Civic Auditorium, San Francisco, Calif.

August 30-September 9

INTERNATIONAL LEIPZIG FAIR—Leipzig, Germany.

September 3-17

ENGINEERING MARINE AND WELDING EXHIBITION—Olympia, London.

September 13-16

ELECTROCHEMICAL SOCIETY—Corrosion Symposium, Wrightsville Beach, N. C.

September 14-15

AMERICAN HOT DIP GALVANIZERS ASSOCIATION—Semi-Annual Meeting, Statler Hotel, Cleveland, Ohio.

September 14-17

SOCIETY OF AUTOMOTIVE ENGINEERS—National Tractor Meeting and Production Forum, Hotel Schroeder, Milwaukee, Wis.

September 28-30

NATIONAL ELECTRONICS CONFERENCE — Annual Conference, Hotel Sherman, Chicago, Ill.

September 29-October 1

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Middle Eastern District Meeting, Daniel Boone Hotel, Charleston, W. Va.

September 29-October 3

SOCIETY OF AUTOMOTIVE ENGINEERS—Aircraft Engineering Display and Aircraft Production Forum, Hotel Statler, Los Angeles, Calif.

October 7-9

NATIONAL ASSOCIATION OF CORROSION ENGINEERS—South Central Regional Meeting, Mayo Hotel, Tulsa.

October 8-9

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS — Annual Meeting, Hotel Sheraton, Chicago, Ill.

October 8-9

SOCIETY OF THE PLASTICS INDUSTRY—New England Section Meeting, Equinox House, Manchester, Vt.

Catalogs and Bulletins

Request additional information using postcards following page 240

(1) BELT DRIVES—Pyott Foundry & Machine Co., Catalog V-1000, 56 pp. Has charts, specifications, formulas, and engineering diagrams on belts, bushings, stock drives, and sheaves. Has calculations of centers VV drives; fixed center drive formula; quarter turn drives; and other engineering data.

(2) PNEUMATIC RECEIVERS — Minneapolis-Honeywell Regulator Co., Specification Sheet 285, 4 pp. Describes pneumatic receivers, which are furnished as indicating controllers, recorders and recording controllers. Pneumatic receivers are actuated by spring and bellows units which receive pneumatic signals from transmitters.

(3) WIRING DIAGRAMS—Allen-Bradley Co., Bulletin 24 pp. Describes the many ways that an across-the-line starter can be applied. Illustrates wiring diagram symbols and line diagram symbols. Each wiring system shown in two ways: a wiring diagram and a line diagram. Wiring diagrams shown for all sizes of starters; 1, 2, and 3-phase systems, and many others.

(4) INDUSTRIAL TEMPERATURE MEASUREMENT & CONTROL—The Partlow Corp., Bulletin 101, 24 pp. Presents the basic principles of industrial temperature control in practical fashion. Defines different types of control systems and distinguishes between them for purposes of selection and applications. Has many illustrations.

(5) STAINLESS STEELS—Armco Steel Corp., Booklet 8 pp. The extra low carbon grades of stainless steel, 18-8 ELC (type 304 L) and 18-12 Mo ELC (type 316 L) are fully ex-

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plained. Covers: why carbon causes corrosion; how special steels conserve scarce alloys; how to weld them; and other points. Well illustrated and includes tables on chemical analysis, and mechanical properties.

(6) PUMPING PROBLEMS—Geo. D. Roper Corp., Catalog 953, 36 pp. Titled, "How To Solve Pumping Problems", it has an introduction which explains and illustrates the operation of rotary gear pumps. Three sample problems show the computations necessary to apply these pumps on representative jobs. Also has charts and data relating to various pump application.

(7) THERMISTORS—Victory Engineering Corp., Booklet, 36 pp. Describes the type 71A2 high resistance thermistor, sealed in a glass rod, and having a temperature coefficient of —7 percent per degree cent. at zero deg. C. Explains types of construction; typical uses; time delay devices; switching devices, and other data and illustrations.

(8) OIL HYDRAULIC PUMPS & CONTROLS—Vickers, Inc., Catalog 5001, 56 pp. Gives complete description and latest specification data on a line of pumps, valves, cylinders, power units, transmissions, and control devices, for oil hydraulic machinery operation. Has many detailed diagrams and cross-sectional views showing oil flow, plus complete engineering information.

(9) AIR & HYDRAULIC CYLINDERS—Miller Motor Co., Bulletins A-105 G, H-104 G, 16 pp. Has complete data on a line of non-rotating air cylinders. Has mounting data and dimensions for zero stroke double acting and single acting cylinders. Has large cutaway view of cylinder. Has similar data for high pressure hydraulic cylinders in 1½-12 in. bores, 2000 psi and up.

(10) SMALL GEARING—Gear Specialities, Inc., Booklet 6 pp. Has many illustrations and a description of various types of worms and gears. Shows armature shafts with worms, spurs and spiral pinions from ¼ to ⅝ in. Shows: spiral bevels; ratchets; spurs; worm & gear; gear train; rods;

internal gears; helicals; spring loaded and compound gears; racks; and others in all metals and bakelite.

(11) SEALING PROBLEMS — The Rotary Seal Co., Booklet 547, 14 pp. Has illustrations of and describes the purpose of each part. Covers the rotary seal assembly, the seal face, the friction ring, the retaining shell, the friction ring band, the spring and holder, and the stationary seal seat. Illustrations show some typical applications, and chart gives range.

(12) BALL & ROLLER BEARINGS —Morton Bearing Co., Catalog 52, 10 pp. Has specifications for flat race ball thrust bearings; grooved race ball thrust bearings, also with spherical seats and self aligning; banded ball thrust bearings; roller thrust bearings; and some special types of ball thrust bearings. Illustrations of all types.

(13) TEMPERATURE CONTROLLERS—Leeds & Northrup Co., Catalog ND 47, 20 pp. Complete data on electronic instruments for two position or proportional control. Completely illustrated, it shows how three types of controllers regulate temperatures up to 1000 F. Also covers conductivity controllers.

(14) THERMAL TIME DELAY RELAYS—G-V Controls Inc., Booklet 30, 4 pp. Describes miniature and octal size thermal time delay relays of the hermetically sealed adjustable type. Includes cutaway views of the stainless steel mechanism and metal shell, curves of operating characteristics, and specifications of the six units available. Delay intervals range from 3 sec. to 5 minutes.

(15) SMALL INDUSTRIAL PUMPS —Tuthill Pump Co., Catalog 101, 12 pp. Gives complete information on a line of rotary, internal gear, positive displacement type pump equipped with a mechanical seal. Has dimension and mounting diagrams; parts diagram; seal assembly; and characteristic performance curves.

(16) SILICONE VARNISH—Dow Corning Corp., Data Sheets, 4 pp. Complete engineering data on silicone varnish 997, a class H dipping and impregnating varnish said to have

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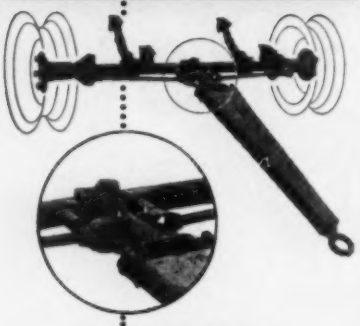

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Stability for the heaviest loads is provided by massive center steering arm, extra-heavy center arm stop blocks and heavy duty steering knuckle. Wide inside wheel turning angle assures maximum maneuverability and eliminates jack-knifing.

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over 100 times the dielectric life of typical class B varnishes at 200 C. Lists typical properties, and curves show thermal life.

(17) POLYESTER RESINS—General Electric Co., Booklet CDC-238, 24 pp. Contains detailed information on industrial applications for polyester resins. Discusses catalysts, fillers, and pigments used, and fabricating methods. More than 20 tables and charts give complete property data on six resins.

(18) HYDRAULIC VALVES & DEVICES — Fluid Controls Inc., Booklet, 4 pp. Illustrates and describes three general classifications of hydraulic valves and devices made. Illustrations of valves, plus applications on material handling equipment, machine tools, and testing equipment.

(19) SELF-LOCKING NUTS — Standard Pressed Steel Co., Booklet 866, 4 pp. Describes the regular height nut, the thin nut, the clinch nut, and the external wrenching nut. Sizes up to 1 and 2 in. Nuts do not have to seat to lock and can be used as stop nuts. Steel nuts used up to 550 F, and corrosion resisting steel nuts up to 750 F.

(20) METAL HOSE DATA—Universal Metal Hose Co., Data Book U-111, 24 pp. Has information on application, temperature ranges of various types of metal and wire braided hose, dimensions, couplings, assemblies, and other data. All types of hose are illustrated, and sectional diagrams given.

(21) MINIATURE CLUTCH — High Precision Inc., Booklet, 4 pp. Data on a one-way roller clutch as small as $\frac{1}{2}$ in. in length and $\frac{11}{16}$ in. in dia. for use in recording instruments, business machines, servo mechanisms, and control devices. Has illustrations of parts and unit used in special application.

(22) PERMANENT MAGNETS—Thomas & Skinner Steel Products Co., Bulletin 151, 20 pp. Topics discussed are: the application of permanent magnets; fundamental properties; problems of magnet design; testing the magnet; magnetic attraction; mechanical considerations; magnet steels;

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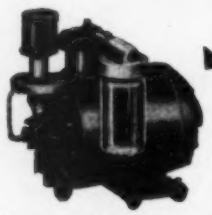
Standard Model 0210, ¼ H.P., 1.3 C.F.M. to 25 P.S.I. or 27" vacuum. Oil-less Model, to 10 P.S.I. or 15" vacuum.



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alnico grades; and permanent magnet materials. Has many curves, illustrations, and charts.

(23) HEAVY DUTY RECTIFIERS —Electronic Rectifiers, Inc., Booklet, 6 pp. Has complete engineering data on a line of lightweight heavy duty rectifiers for general use for d-c up to 60 V, 50 to 50,000 amp., and operation from —40 F to 284 F. Has wiring diagrams, load curves, and other information.

(24) MERCURY RELAYS & SWITCHES—Durakool, Inc., Bulletins 800 and 525, 10 pp. Contains illustrations, cutaway views on a line of mercury relays with capacities up to 60 amp, and a-c voltages up to 440, and d-c to 550 volts. Principle of operation of switch given, as well as data for all sizes.

(25) FLEXIBLE COUPLINGS — Lovejoy Flexible Coupling Co., Booklet 515, 52 pp. Has many illustrations and specifications and dimensions of couplings with hp ratings from 1.5 to 156 at 100 rpm. Has large operating capacity chart. Also has much engineering data on many sizes of variable speed transmission units, plus many application illustrations.

(26) COUNTING INSTRUMENTS —Production Instrument Co., Catalog 54, 8 pp. Listing a counting instrument for every purpose, it contains specifications for all types, features, and many illustrations. Also shows selection monitor automatic batch counters, and various actuating switches.

(27) AIR CLEANER—Logan Engineering Co., Catalog 252, 8 pp. Describes the Aridifier, a mechanical cleaner that removes 92 percent of oil, moisture and dirt from compressed gas and air lines. Explains operation and installation, has cross section view, curves showing capacity of different size units, and other data.

(28) NEW ENGINEERING MATERIAL—The U. S. Graphite Co., Catalog, 66 pp. Contains full information about Graphitar, a new material that may be used for seals, bearings, end plates, valves, piston liners, and other parts. It is made from carbon and graphite powders, compacted

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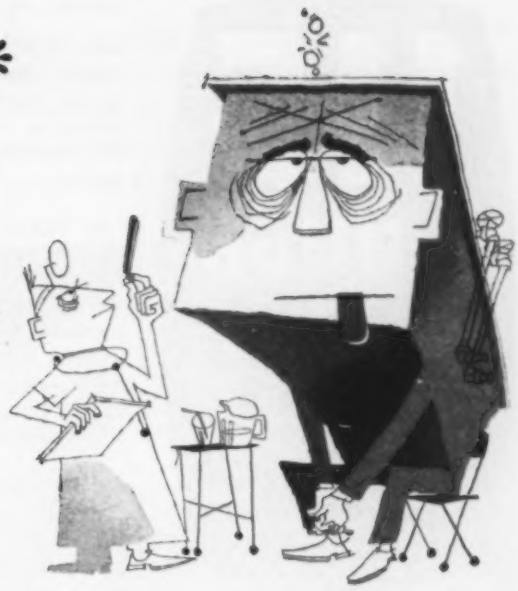

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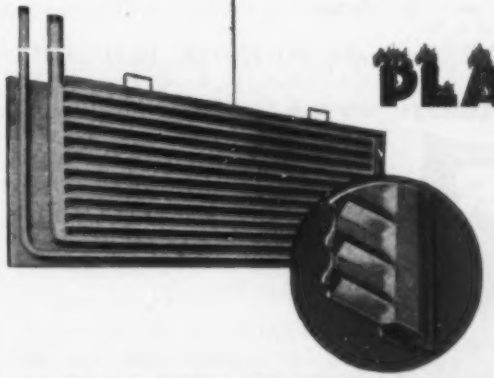

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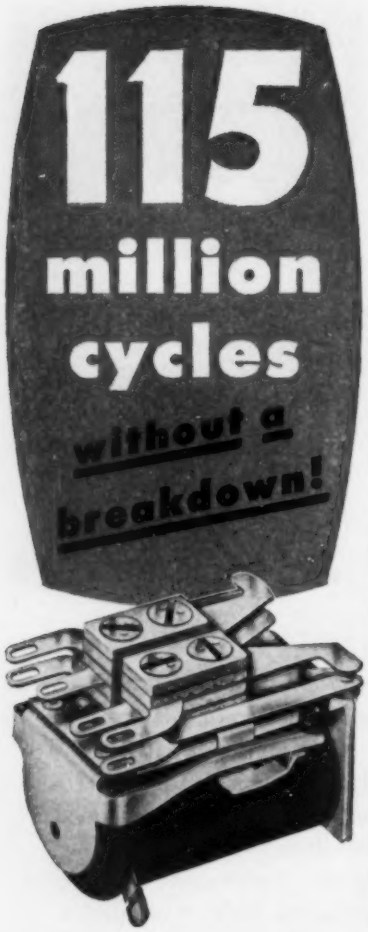

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Catalogs and Bulletins.....continued

under high pressures, and furnaced at 3000 F. Harder than most steels and lighter than magnesium. May be ground to tolerances of 0.0005 in. Has many illustrations showing application.

(29) SERIES MOTOR PARTS — General Electric Co., Bulletin GET-2297, 12 pp. Completely illustrated with charts, curves, cutaway views, formulas, and diagrams, it contains selection and application data on series motor parts for built-in applications. Also discusses ventilation, brush life, armature balance, and backlash.

(30) RELAYS—American Relay & Controls, Inc., Catalog R-10, 12 pp. Has complete engineering data on a variety of relays, such as: snap-action switch contacts; plug-in mountings; hermetically sealed and dust-tight units; overload relays; latching relays; and relays with screw terminals. Has many illustrations, operating data

(31) VARIABLE SPEED DRIVES —Graham Transmissions, Inc., Bulletins, 26 pp. Has much technical data on a speed changer built as a straight-line extension of an induction motor. Line drawings show how all speeds to zero and reverse are obtained, and torque curves are included. Many illustrations are included, plus a variety of controls.

(32) AIR CONTROL VALVES—Mechanical Air Controls, Inc., Catalog 53, 36 pp. Has an illustration, cutaway view, and specifications for: a variety of solenoid operated valves, 3 and 4-way spring return and others; foot operated valves; cam operated valves, base mounted; pilot pressure operated valves, base mounted; hand operated valves; and line mounted valves.

(33) POLYESTER FILM APPLICATIONS—E. I. du Pont de Nemours & Co., Technical Bulletin 1-2-53, 18 pp. Contains information on the physical, electrical, and chemical properties of Mylar polyester film, and suggested applications. Has several charts, diagrams, and tables, and compares it to cellophane, polyethylene, and acetate.

(34) PRACTICAL NICKEL PLATING—International Nickel Co., Bulletin 77, 44 pp. Has over 40 illustra-

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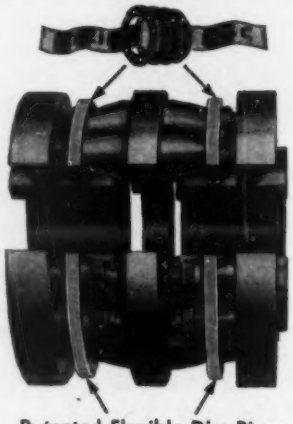

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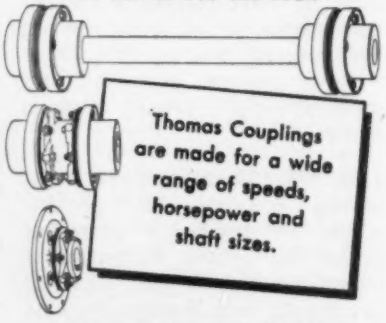

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tions, tables and charts together with basic information on electroplating, and detailed information on nickel plating and its practices. Thickness and type of nickel deposit for adequate service life in many corrosion resistant, industrial and electroforming applications are discussed.

(35) GENERAL PURPOSE STARTERS—Allis-Chalmers Mfg. Co., Bulletin 14 B 7733, 4 pp. Information on selecting the right starter for squirrel-cage induction motors rated up to 600 hp at 600 V or less. Tells how to select the proper type starter, enclosure and operating arrangement. Also has explanation of 2 or 3-wire control, and hints on the selection of heater elements for overload relays.

(36) CONVEYOR CHAINS & SPROCKETS—Diamond Chain Co., Bulletin 29, 24 pp. Has many illustrations showing various types of attachment links for conveyor chains, rollers, with specifications for all types and sizes.

(37) PRECISION INSTRUMENT BALL BEARINGS—New Hampshire Ball Bearings, Inc., Catalog 53, 28 pp. Includes dimensional and design data on 137 Micro ball bearings in bore sizes of 0.025 in. to $\frac{5}{16}$ in., to 0.100 in. to $\frac{1}{2}$ in. O.D. Also discusses loads, speeds, mounting, lubrication, tolerances, and gaging and handling of instrument bearings.

(38) PRESSURE REGULATORS—Moore Products Co., Bulletin 4003, 8 pp. With a large 3-color illustration, it describes the Nullmatic pressure regulator, a pilot-operated instrument operating on a pneumatic null balance system. Charts and curves give pressures and performance characteristics.

(39) D-C GENERATORS—Columbia Electric Mfg. Co., Bulletin 600, 4 pp. Describes a complete line of d-c generators up to 300 kw, plus illustrations of available frame sizes and special design features. Has details of construction for field frames and coils, armatures, commutators, brushholders and other parts.

(40) CASTING RESIN — Durez Plastics & Chemicals, Inc., Booklet, 16 pp. Data on a thermosetting resin in liquid form that can be cast in simple molds, and requires only a

short baking cycle at 140 F. Information for use in electroplating shields, masking fixtures, model or prototype work, patterns, and others.

(41) DIESEL ENGINE DEVELOPMENTS—Worthington Corp., Bulletin S-500-B55, 14 pp. Titled, "New Developments in Oil Diesel, dual fuel diesel, and High Compression Spark Ignition Engines", it describes and illustrates up-to-date features of modern, heavy duty internal combustion engines. Includes a heat balance chart, and fuel cost chart for engine selection.

(42) ROTARY PRESSURE JOINT —Anco, Inc., Booklet, 4 pp. Specifications for a rotary pressure joint to convey steam under pressures up to 350 psi, and a hydraulic joint for liquid pressures up to 3500 psi. Will take misalignment up to 10 degrees, and available in pipe sizes from ¼ to 5 inches. Has large cutaway view showing separate parts.

(43) PRECISION POTENTIOMETERS—Servotrol Co., Booklet, 6 pp. Has complete specifications as to: materials; electrical; and mechanical specifications for a line of single organized potentiometers. Has illustrations of applications, and lists others.

(44) PRECISION HYDRAULIC EQUIPMENT — The Bruning Co., Catalog, 14 pp. Has data on cylinders, check valves, quick-disconnect couplers, and other components. Has cross-sectional views of parts, curves giving flow ratings, charts with pressure ratings, and other information.

(45) SELENIUM RECTIFIERS — American Rectifier Corp. Bulletin 271, 4 pp. Explains the application of rectifiers to various operations. A list of questions frequently asked along with the answers, giving the benefits of keeping d-c equipment working on a-c while retaining d-c speed control. Units made in sizes from 3 to 1,000 kw, from 50 to 10,000 v d-c output, fixed or variable.

(46) MODERN MEASURING INSTRUMENTS — Brush Electronics Co. Booklet ED-21701, 34 pp. Titled "Instruments for Modern Measurements', it illustrates and describes over 37 different instruments for electrical, physical, and resistance-welding measurements, ultrasonic energy applications and others.

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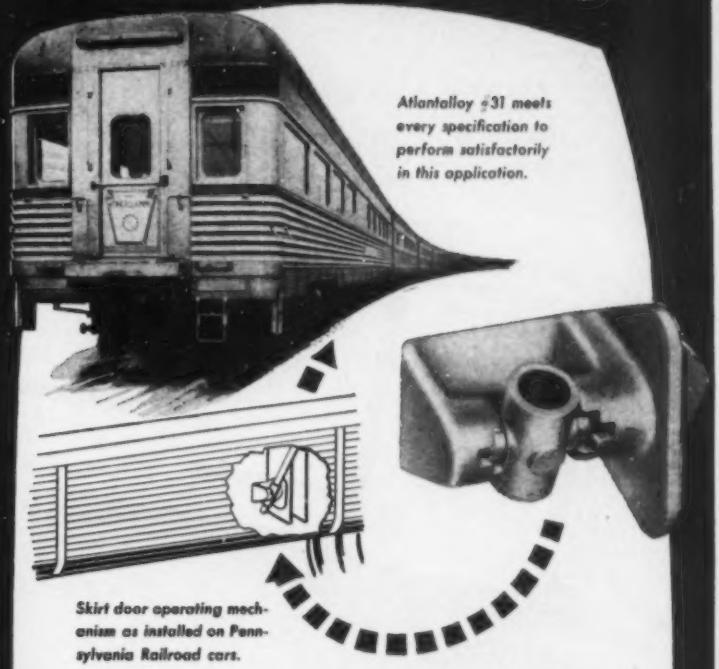

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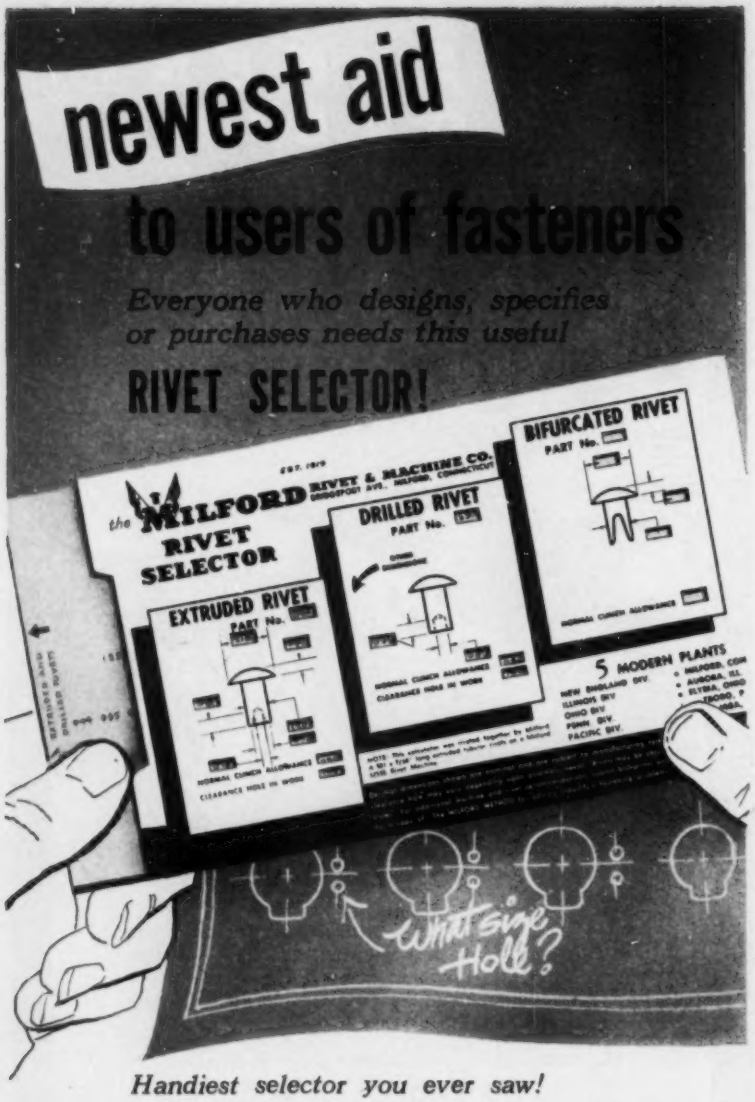

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Sans, Souci

Ad Libbing by the Editor

It seems that the April editorial, "A Graduate Can Measure A Bottle" stirred up quite a few engineers. I received quite a few personal letters concerning it and here is one of particular interest from Murray Ogman of San Diego. Taking just a few excerpts from his letter, but not changing any of his sentences, he makes the following points:

"At one extreme is the engineer who wants to calculate everything and at the other extreme is the engineer who wants to get every answer by cut and try. Admittedly, many projects defy mathematical analysis. But there are also problems on which time and money is wasted on the project because of the failure to apply elementary algebra.

"I grant you it is simple to measure a bottle with a graduate glass, but the problem is not always that simple. Today we see the bottle transforming itself into a servo mechanism, a heat transfer problem, an electronic computer or similar complicated devices. I have seen complicated systems set up on a cut and try basis and the systems were still not working properly after innumerable trys. On the other hand I have seen systems set up on a mathematical basis and then designed and built. It wasn't expected that they would be successful at the first trial and usually they did not work properly at first. It was realized from the beginning that actual tests and trials would have to be made. But the application of mathematics did save a tremendous amount of time and money by eliminating a large amount of guess work.

"From my observations the trend of engineering is away from cut and try design work by virtue of the increasing complexity of the problems being encountered. I grant you again that cut and try methods will still remain but the application of mathematical analysis will always reduce cut and try operations considerably. Efficient and successful engineering is the application of a generous quantity of both of these extreme techniques."

I must admit that Mr. Ogman has stated the whole problem beautifully.

Common sense and calm engineering judgement must decide the line of attack on a problem.

People like to be nice. But unfortunately, there are some reasons for being nice that are not commendable. I have in mind the little "apple polisher" who is trying to wheedle high marks out of his teacher without doing much studying. Later in life he is the same fellow in business who tries to wiggle into a high salaried position without giving commensurate service value to his company, all through the medium of "being nice".

And then of course we have those individuals who insist on always being nice for fear that they might get punished or fired if they are not. They don't count.

And then there is the fellow who is so afraid of stepping on other peoples' toes that he stands still. He is the fellow who is just so nice that he stays in the same job. Ironically, the fellow who attempts always to be nice often imposes a terrible injustice on someone else.

There is the boss who wants to be nice to the employee who is such a nice fellow and who "really needs a raise" more so than others in the department. So the soft hearted boss puts through a fat raise in order to "be nice" to the fellow who perhaps has done a little apple polishing but in any case is getting a lot of sympathy. Of course the fat raise uses up quite a portion of the total budget set aside for salary increases with the result that others in the department get little or no increase in salary. This, in spite of the fact that they have contributed relatively much more to the success and profits of the company.

Obviously a great injustice has been done. On the other hand, if the boss fails to get a raise for "the man in need" who hasn't earned it he may be severely criticized as being hardhearted and inconsiderate. There is nothing new in that. A fellow who cannot stand up against that kind of criticism doesn't have the essential qualities for being a boss. A nice boss is not always a good boss.

Stepping On Toes

There is always a time in a man's career when it is absolutely necessary for him to step on toes. Failing to do so might cause loss to the company, injustice to an individual or may make

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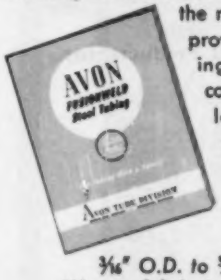

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impossible further advancement for himself. When major decisions are being made, he should argue militantly for the right as he sees it. If his thinking is sound and if he presents his viewpoints clearly, forcefully and logically and in a constructive manner, he will win regardless of the decision.

Any man who expects to progress should not fear stepping on the toes of his associates and superiors. If he allows such a fear to dominate him, he will stand still.

It's the Splash That Hurts

There are innumerable acts in life that deviate from the straight and narrow path yet give a quick and powerful "lift". That applies to personal operations and business operations with equal effectiveness. An individual can get a tremendous thrill out of hocking his future in order to acquire at the same time an automobile, a television set, a home and other things that may be beyond his ability to pay for, even on the installment plan.

Similarly a business can put on a wonderful front by using up its reserves for other than profit producing purposes. These situations are often insidious in that a small dose is constructive whereas an excessive dose becomes fatal. It is like the difference between a cocktail before dinner and a binge. Too many of us fail to understand the difference.

Of course there is a great thrill in a high dive as the expert diver gracefully floats through the air. And because it is a much practiced and carefully executed operation the diver enters the water with hardly a splash. He has performed like the business concern that has put in a great deal of "practice time", that has tested its venture or expansion carefully and that first makes a modestly high dive which ends up with a nice little splash of profit.

But the business concern or individual who without proper preparation decides to make "a plunge" instead of a dive of modest height to test his venture, invites disaster. At first it's thrilling. Perhaps the man who from a great height jumps off into space gets the same kind of thrill. Then comes the moment of reckoning. In both instances the finale is disastrous. And that is the way with busi-

ness enterprises and personal enterprises wherein the organization or individual undertakes a new venture without carefully thought out plans and tested procedure. Or we might say carefully thought out designs and tested models.

Your Boss's Job

Many a fellow wonders why his boss is his boss. He is certain that the boss is not as good as one of the men working for him. In fact, he may be thoroughly convinced that his boss is not as good as he would be on the same job.

Now the truth is that in very many instances there will be a man working for the boss who is far better than the boss and usually the top executives in the company know it and know it very well. But here is what the vice president of a large and successful corporation said:

"If this company were to attempt to promote every man who looks as though he could do his boss's job a little better, and make that promotion to the boss's job effective as soon as the fact was established, this company would be spending all of its time organizing and reorganizing and we would never get settled enough to get any work done. And on top of that, only too often it is merely a matter of opinion as to whether or not the underling can do the job better. Only when the underling is extremely better than the boss can we be certain of that relationship."

All of which goes to show that you have to be decidedly better than your boss before you can expect to get his job. Even under that circumstance you may have to wait a while. The wait is essential for a number of reasons. One of them is the reason explained above. But in addition, a company cannot operate ruthlessly in promoting, demoting and firing. Such an operation would demoralize the personnel completely and the company would not last long. Some organizations have tried to operate that way and found out that it just doesn't work. The greatly successful companies today are very mindful of the personal welfare of their employees and want them to feel secure in their jobs. Such an additude pays big cash dividends, as does the observance of all the other teachings contained in the Sermon on the Mount. —G. F. N.

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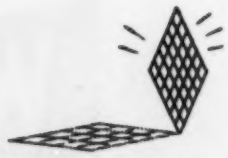

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ENGINEERING ABSTRACTS

Effect of Pressure on Tensile Properties of Some Metals

Abstracted from "The Effect of Pressure on the Tensile Properties of Several Metals and Other Materials" by P. W. Bridgman, Lyman Laboratory of Physics, Harvard University; *Journal of Applied Physics*, Vol. 24, No. 5, May, 1953.

TO DETERMINE WHETHER THE EFFECT of pressure on the tensile properties of nickel, tantalum, columbium, molybdenum and tungsten resulted in (1) a large increase in ductility, (2) a linear relationship between strain hardening and pressure, (3) a linear dependence of the strain at fracture on the supporting pressure, and (4) an empirical connection between reduction of area and profile of contour, tensile tests were made. Five polycrystalline samples were tested to fracture under hydrostatic pressures up to 30,000 Kg per square centimeter.

Results showed large increases in ductility under pressure. Strain hardening at first increased sharply with pressure, but several metals exhibited strain hardening curves that turn over with eventual strain softening. Based on the appearance of the test specimens, the softening resulted from a lack of homogeneity in the original material, not being an intrinsic property of the metal. The strain hardening curves differ greatly in this general appearance, some rise abruptly with a sharp turn-over followed by a long tailing off. Some rise gradually to a flat maximum followed by an abrupt drop. All the metals exhibit progressive changes in the character of the fracture. The original cup-cone disappears and the fracture occurs on jagged prongs or on shear planes.

NICKEL. The Curve in Fig. 1 is a plot of stretch versus total load. Speci-

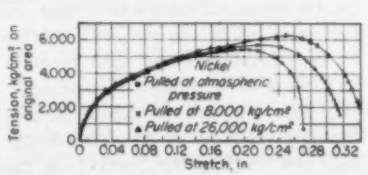

FIG. 1—Curves of load versus stretch for nickel at various pressures.

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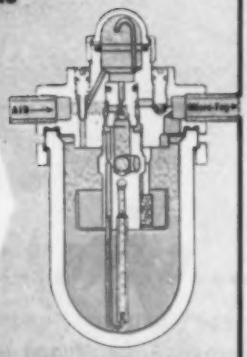

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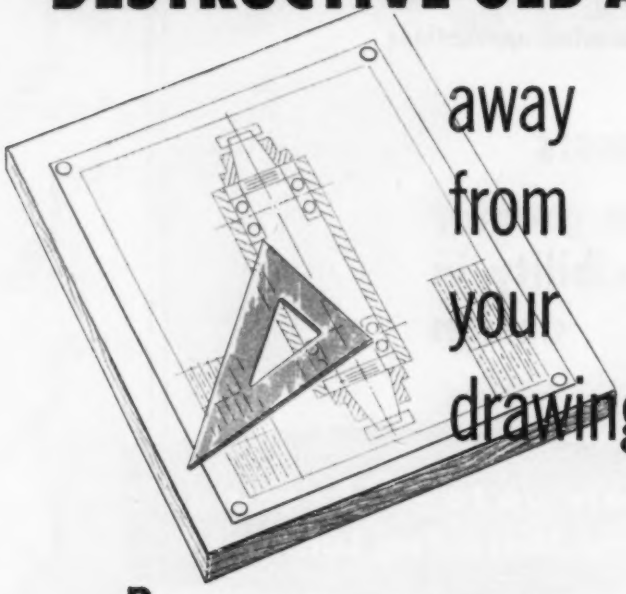

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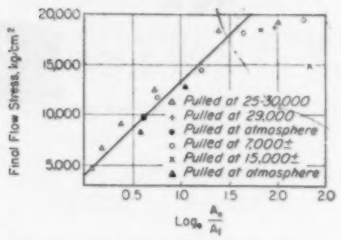


FIG. 2—Strain hardening curve for nickel.

mens were pulled at different pressures, the curves rising higher and the elongation becoming larger at increased pressures. Fracture under a pressure of 7,700 Kg/cm² occurred at a strain of 2.58, a reduction of area equivalent to 92.5 percent.

The strain hardening curve for nickel is given in Fig. 2. Throughout most of the range, the curve exhibits a linear tendency, but beyond a strain of 2.0, the curve turns down indicating that, at extreme strains, there is a softening rather than a hardening. This tendency probably results from actual material damage to the specimen which is substantiated by the appearance of the fracture at rupture.

The empirical relationship found for steel between strain and A/R does not hold true for nickel. An excess of about 7.0 percent means a smaller curvature in the contour than for steel, consistent with the delayed appearance of necking. At low pressures, the character of the fracture was a rough cup-cone, more irregular than for steel. At high pressures, the tendency was to draw out to a chisel edge.

Tantalum. The general nature of its stretch vs total load curves is strikingly different from that of nickel. The curves rise to an early maximum followed by a long gradual tapering off.

Flow stress tends to increase linearly with strain up to a value of 2.0. Pressure shows a definite effect on strain hardening, the flow stress being greater for the same strain at higher pressures. Actually, the rate of increase of strain is only half that of nickel. Shapes of the necks of the tension specimens of nickel and tantalum diverge in opposite directions from that of steel. This is substantiated by the fact that the correction factor determined by using the empirical relationship between strain and A/R that was valid

for steel is too high for tantalum, instead of too low as for nickel.

Fracture of tantalum at atmospheric pressure shows a crudely developed crater with coarse granular structure. At higher pressures, the structure becomes finer and the crater changes into a knife edge.

Columbium. The maximum total load and elongation are greater under pressure, being similar to tantalum and nickel. The maximum is 4,600 Kg/cm² under a pressure of 28,000 Kg/cm²; and 3,900 at atmospheric pressure. This shows for 10,000 Ks/cm² an increase of 6.4 percent.

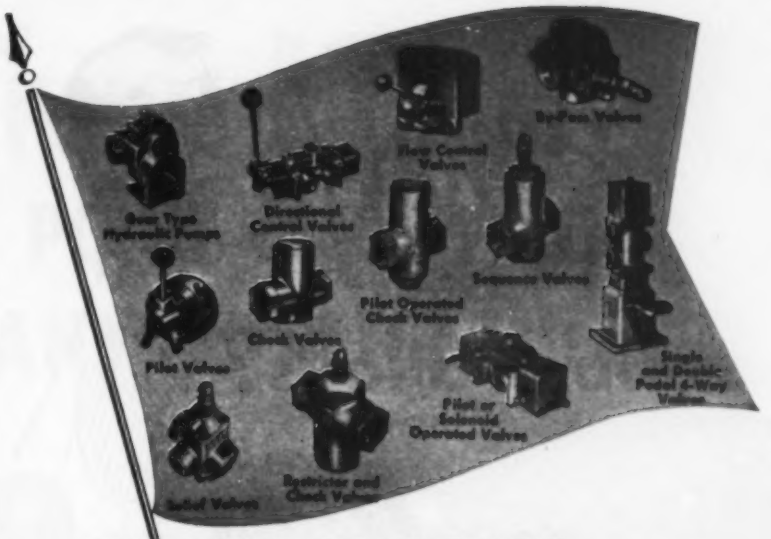
The strain hardening curve for columbium indicates a rate of increase of hardening that is high compared to other metals. Strain hardening does not tend to exceed a strain of 2.5 because of deterioration in the material. An average stress on the section was 11,700 Kg/cm² at a strain of 1.54, and 12,000 Kg/cm² at 2.47. The maximum load occurs at a strain intermediate between that of nickel and tantalum, nearly that for steel. Thus, the correction factor agrees fairly well with that determined for steel, the only difference being the direction because of earlier necking.

Pulling under pressure was more effective in imparting hardening than pulling at atmospheric pressure. The fracture at atmospheric of a pre-pulled specimen was a cup-cone similar to that obtained without prepulling.

Molybdenum. The general character of the molybdenum curves is like that for tantalum—an abrupt rise to an early maximum followed by a long tailing off. Ductility increases notably with pressure. The specimen pulled at atmospheric pressure fractured at an elongation of 0.065 in., at a total load 8 percent less than the maximum. But the elongation of the specimen fractured at 28,000 Kg/cm² was 0.22 in., the load less than one percent of maximum.

Molybdenum shows a strain hardening rate that is unusually high and also a large dependence on the pressure of pulling. The flow stresses are a linear function of strain up to a strain of about 1.2 when material deterioration begins.

The correction for reducing mean stress to flow stress in terms of the



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measured contour was smaller than the correction given by the empirical relationship between contour and strain. This discrepancy was also in the opposite direction as indicated by the early necking.

Fracture at atmospheric pressure gave a rough surface without a cup-cone effect. At higher pressures, the fracture changed into a jagged pattern.

Tungsten. This metal breaks at atmospheric pressure without any measurable reduction of area. However, the absolute strength of tungsten is almost twice that of the four preceding metals. The maximum load increases with pressure from 11,800 under 7,000 Kg/cm² to 13,000 under 28,000 Kg/cm². This represents an increase of 4.5 percent for 10,000 Kg/cm², the same general order of magnitude as for steel and the other metals. Tungsten exhibits a second yield point which becomes more pronounced at higher pressures. Its rate of elongation with pressure is less than that of steel, and corresponds to a carbon steel heat treated to C-56 Rockwell.

Strain hardening data for tungsten indicate little effect of pressure on strain hardening. The relationship with pressure appears to be linear up to approximately a strain of 1.0, when marked deterioration begins.

Correction of the shape of the contour to reduce average stress to flow stress is less than that given by the empirical relationship for steel, meaning that A/R at the same strain is less for tungsten than for steel.

Up to 16,000 Kg/cm², the fracture is finely granular perpendicular to the axis of the specimen. At 27,800 Kg/cm², the fracture is irregular.

Mechanism of Fretting

Abstracted from "The Mechanism of Fretting" by I-Ming Feng and B. G. Rightmire, presented at the American Society of Lubrication Engineers 8th Annual Meeting.

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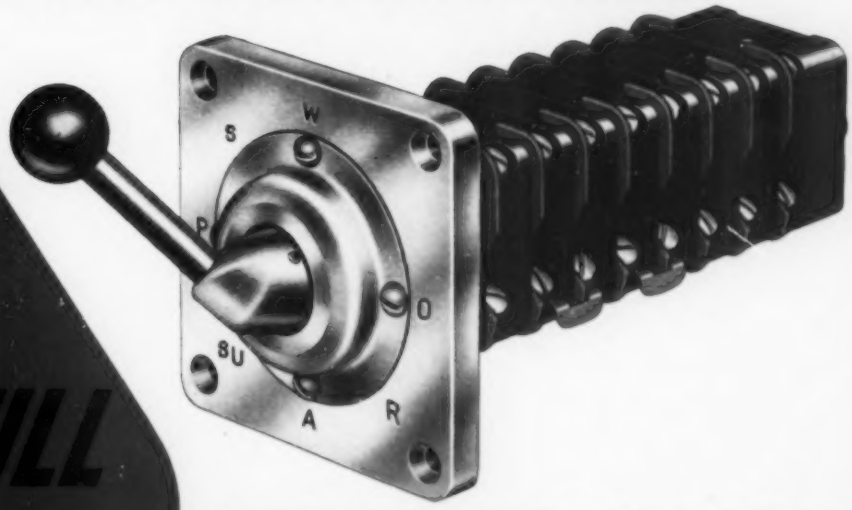

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8 OPERATIONS

involving spindle motor, coolant motor, brake and a "Safe" position.

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6 Magnetic Units	1 Magnetic Unit
7 Push Buttons	1 "PPS" Switch
11 UNITS . . .	SAVED

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8 OPERATIONS

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1 Timer	1 Timer
14 Push Buttons	1 "PPS" Switch
16 UNITS . . .	SAVED

COMPARE
AN AUTOMATIC BAKELITE PRESS
8 OPERATIONS

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1 Timer	1 Timer
9 Push Buttons	1 "PPS" Switch
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TURN THE PAGE FOR AN ELECTRICAL DESCRIPTION and OPERATIONAL FEATURES

Control TAILORED TO YOUR EXACT NEEDS

— THE ARROW-HART "PPS" SWITCH IS CUSTOM BUILT TO YOUR SPECIFICATIONS FROM STANDARD COMPONENTS

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What the "PPS" does

- **A SINGLE "PPS" UNIT PROVIDES SINGLE-POINT CONTROL . . .** involving practically any desired circuit arrangement.
- **THE "PPS" REDUCES THE NUMBER OF CONTROLS REQUIRED**
  - — because it is the **ONLY** pilot device required for practically all installations.
  - — because the "PPS" makes a single ***MAGNETIC*** control (starter, contactor etc.) do the work of many.

Here IS THE BASIC OPERATING PROCEDURE SIMPLE AS A-B-C

A **PUSH and TURN TO SELECT . . .** The operator must first push the handle — opening all circuits and disconnecting all controls. The handle can then be turned to any desired position; this selects the correct circuits for the required function. Any number of unwanted, intermediate functions can be passed without energizing their circuits.

B **PULL TO START . . .** With the handle in the desired position, the handle is **pulled** to start the operation — the same as actuating a conventional "Start" button.

C **PUSH TO STOP . . .** Pushing the handle immediately stops the operation. "PPS" single-point control is safer in emergencies because there is never a delay to find the right button.

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This new concept in motor control can help solve your present tough control problems . . . and help you build peak performance into your new designs. Use the coupon, attached for your convenience, to send for completely descriptive literature including a sample Target Sheet for plotting your circuit requirements.

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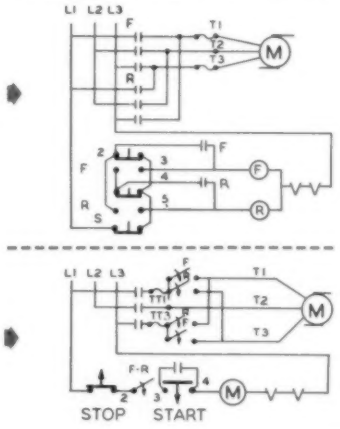
How the "PPS" works

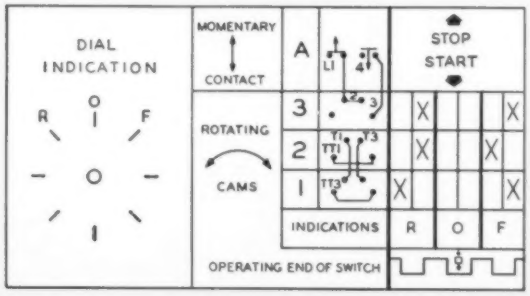
To explain the action of the "PPS", let us look at an example; the simplest possible is the standard reversing of a motor. This example will show how the required number of magnetic units is reduced and how single-point control will serve for any number of operations.
While your own actual control application may be more complex than this example, it will simply entail using enough additional circuits to accomplish the required combinations of load and control hook-up.

CONVENTIONAL CIRCUIT . . . This diagram shows the familiar type of reversing circuit. 3 push buttons and 2 magnetic units are required.

"PPS" CIRCUIT . . . Here the Rotating Cam Sections of the "PPS" select the circuit, and the Momentary Contact Sections operate the motor as desired. The diagram also shows the symbol used for "Stop" by pushing and "Start" by pulling. Only 1 *magnetic unit* and 1 pilot device, (the "PPS"), are required.



THE "TARGET SHEET" . . . shown here in abbreviated form, is the means by which your control requirements are translated into a diagram for the construction and wiring of a "PPS" Switch. A wiring diagram strip shield is visible from the top of every switch you buy indicating the terminals and all internal and external connections on the "PPS".



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THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
HARTFORD 6, CONN., U.S.A.

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celerated. Moreover, oxidation of wear particles further accelerates the abrasive action.

Concentrated mechanical wear is the primary cause of fretting, and accumulation of trapped wear product and oxidation of wear particles are the secondary causes.

The mechanism of metallic wear as suggested by Feng is briefly as follows: When a pair of contacting high spots carries a load that is great enough to cause plastic deformation, the interface of these high spots will be roughened. This roughening produces a mechanical interlocking effect that strengthens the interface in resisting tangential force.

An application of a tangential force will shear off the peak of one high spot, instead of separating the spots along their original interface. The small particle of metal sheared off becomes a loose wear particle if there is nothing to keep it adhering to the other high spot.

When the surrounding atmosphere is inert and the relative motion is unidirectional or the amplitude of the alternating motion is large, the loose wear particles have a good chance to leave the space between the surfaces and hence produce little abrasive wear.

When the relative motion is oscillatory with small amplitude and the surrounding atmosphere is inert, the wear product will be trapped and accumulated among the contacting regions of the two surfaces, and hence produce abrasive action. If, in addition, the loose wear particles are oxidized instantly when they are formed, the hardness of the oxide may further accelerate the abrasive action.

Wear particles, however, are not usually oxidized instantly. Therefore, those that are in contact with the surfaces of the parts and that produce an abrasive effect are distributed among other metallic particles that are in partially oxidized and fully oxidized states.

Fretting will not occur if mechanical wear can be prevented. One way to prevent the initiation of mechanical wear caused by vibration is not to permit relative motion between the surfaces. This can be accomplished by increasing the normal load to such an extent that the external disturbance is completely absorbed elastically in the part and machine. The same end can also be reached by reducing the ex-

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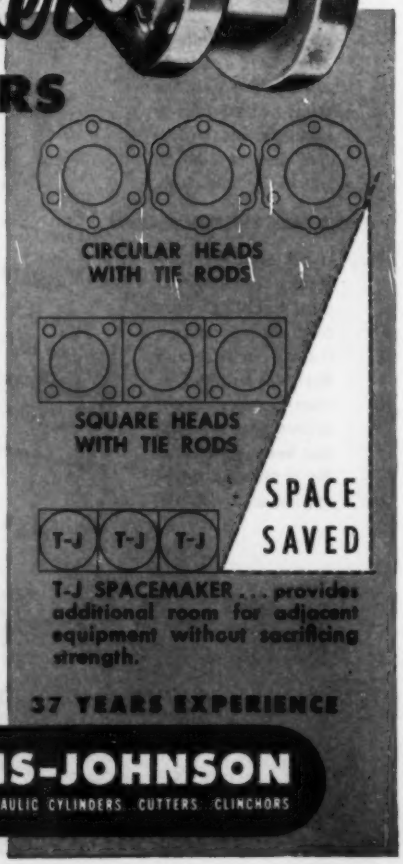
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ternal vibration or other disturbances.

The external disturbance can also be absorbed elastically by inserting material such as rubber between the contacting surfaces.

Another way of averting mechanical wear is to reduce the load to such a small value that none of the contacting high spots is plastically deformed. Such a load is extremely small and this method is impracticable. In the ordinary atmosphere, however, metallic surfaces are always contaminated by absorbed gases, oxides, and greases. It is possible, therefore, to add to the metallic surface film. This film can be solid, or fluid or semi-fluid and, at the same time, adjust the load so that roughening of the interface of contacting high spots, which results from plastic deformation, does not exceed the thickness of the surface film.

Attemps to stop fretting damage by eliminating chemical reaction always show that such damage cannot be avoided entirely by eliminating chemical action. If oxidation were the primary cause of fretting, elimination of oxygen in the surrounding atmosphere would stop fretting completely.

Fatigue Strength and Electroplating

Abstracted from "Fatigue Strength and Electroplating", *Mechanical World*, May, 1953.

ELECTRODEPOSITED METAL is commonly associated with a residual tension and in this respect has an adverse effect on fatigue strength similar to that produced by grinding or straightening or induction hardening. The opposite effect, i.e., a residual compressive stress in the surface zone of the component produced by cold working, peening, polishing, rolling and nitriding, tends to increase the fatigue limit of the base material.

Shot peening has, in many engineering applications, produced quite astounding increases in fatigue life and is now in wide use. It is not, however, a panacea for all fatigue strength problems. In some cases the effect of shot peening may be harmful to fatigue strength, although these are in the minority.

Prestressing in compression by rolling or plain pressing has often produced comparable and in some cases better results and may eventually be-

come a standard method. Profile pressing is particularly satisfactory in dealing with unavoidable stress raisers where the material is made to cold-flow to the shape required by pressing and at the same time the surface of the whole component is stressed in compression.

Prestressing can be considered in relation to the undesirable tensional stresses set up in the surface zone by electrodeposited metals, when the possible solutions become: (1) Prestressing the base metal in compression to overcome the residual tensional stresses of the electrodeposited coating; (2) depositing the electroplated coating in such a way that the residual stresses in it are in compression; and (3) treating electrodeposited coating so as to nullify the residual tensional stresses.

All three alternatives are possible. The first shows no gain in overall fatigue strength and gives only the benefits to be derived by electroplating, e.g., corrosion resistance, rebuilding, etc. The second is a theoretically ideal solution which would improve the fatigue strength of the component. Unfortunately, the plating conditions necessary to produce compressive deposits are somewhat critical. The third alternative offers a useful and practical alternative with no particular engineering problems provided the electrodeposited coating is ductile enough to withstand cold working, e.g., shot peening, without fracture. The deposit of a 'compressive' coating is the most attractive, particularly since such a coating would eliminate porosity, provide enhanced corrosion resistance and be generally more resistant to cracking.

To get a clearer picture of the practical value of these alternative methods of approach to the problem, reference can be made to a number of tests carried out recently by United States government laboratories in connection with test pieces prepared by the research laboratories of the General Motors Corporation. Results are summarized in Tables I and II.

The basic material used was steel, with one specimen finished by polishing and once coated with electrodeposited nickel in tension (normal), and the other with electrodeposited nickel in compression. The plain test piece could in effect, be considered as prestressed in compression due to the

Out at Lima-Hamilton Corp., Hamilton, Ohio, they braze five parts of their 9x12 Diesel locomotive engine. Here are the jobs, the time cycles—also test results quoted from their report.

PART AND JOB	TIME CYCLE	TEST RESULTS
Exhaust rocker arm to shaft induction brazed with a ring of 3/32" EASY-FLO wire preplaced.	318 secs. 2 pieces	"On torque loading the 1¼" rocker shaft twists at 12,000 lbs. No failure of joint."
Intake rocker arm to shaft done same as above.	282 secs. 2 pieces	Same result as above.
Tappet plugs to tappet body, induction brazed with a ring of 3/32" EASY-FLO wire preplaced.	72 secs. each	"Parent metal fails before brazed joint when attempting to press plug from tappet body."
Ball ends to seamless steel tubing push rods, induction brazed with a ring of 1/16" EASY-FLO No. 3 wire preplaced. (Illustrated above)	45 secs.	"Tube bulges before joint failure when attempting to push rod ends out of tubing."
Cup ends to seamless steel tubing push rods done same as above.	50 secs.	Same result as above.

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Table I.—Fatigue strength of plated steel specimens (U.S. Government tests)

Finish	Resid stress in surface	Fatigue limit	
		S, psi	N, cycles
Polished	Comp (15–20,000 psi)	45,000	10^7
Nickel plated	Comp (6000 psi)	46,000	10^7
Nickel plated	Tension 25,000 psi	29,000	5×10^6

Table II.—Fatigue strength of nickel plated specimens (U.S. Government tests)

Finish	Resid stress in surface	Fatigue limit	
		S, psi	N, cycles
Polished	Comp	48,000	10^7
Nickel plated	Tension	20,000	5×10^6
Peened & plated	——	41,000	$5{\cdot}5\times10^6$
Plated & peened	Comp	55,000	10^7

polished finish, presumably of the order of 15,000 to 20,000 psi. The polished and compressive plated specimens showed almost identical S/N curves, the residual compression in the nickel plating determined as being between 15,000 and 20,000 psi. The electrodeposited nickel coating in tension showed a reduction in the fatigue limit of some 35.5 percent.

In another series of experiments (J. O. Almen, "Product Finishing" June 1951), similar methods of treatment with electrodeposited chromium coatings were used. The results, Table III, are essentially similar to those obtained with the nickel plated specimens, although the degree of difference is less. The specimen shot peened and then plated showed a higher fatigue limit than the plain, polished specimen, whereas the reverse was true with nickel plating.

To summarize, prestressing must be studied carefully where optimum fatigue life is required from electroplated specimens. Shot peening offers a practical solution to offset the undesirable effect of electroplating on fatigue strength, applied either to the base metal before plating, or to the component after plating. The former

Table III.—Fatigue strength of chrome plated specimens (Research Laboratories, General Motors Corporation)

Finish	Resid stress in surface	Fatigue limit	
		S, psi	N, cycles
Plain	——	48,000	8×10^6
Chrome plated	Tension	38,500	$1{\cdot}2\times10^6$
Plain, peened	Comp	53,000	5×10^6
Peened & plated	Comp	51,000	5×10^6

should give roughly equivalent fatigue strength as compared with the base material unplated and finished smooth, although this will vary both with the metal electrodeposited and the thickness of the plating. Shot peening after plating offers improved fatigue strength, but not necessarily as high as might be achieved by shot peening applied to the unplated base metal. Compressive electroplating, with its attendant working difficulties, offers roughly the same S/N characteristics as the plain base metal highly finished, as by polishing, with the further possibility that the other characteristics of the electrodeposited coating will be enhanced.

Decimal Dimensioning

Abstracted from "Decimal Dimensioning Saves Time and Reduces Errors" by George E. Rowbotham, Ford Motor Co., Dearborn, Mich. *The Tool Engineer*, June 1953, p 63.

DECIMAL DIMENSIONING offers the advantages of the metric system long advocated by many, without the disruptive work and expense that would be entailed in converting to the metric system. The decimal approach is being used on both engineering and manufacturing drawings of machinery, tools, gages, dies fixtures, and related items. The result is simplified work for the product engineer, draftsman, checker, production engineer, tool and die maker, machine operator and inspector.

The primary advantage resulting from adoption of the decimal system is the simplification of arithmetic computations. The inch is divided into tenths, hundredths, thousandths, etc., instead of unwieldy fractions. Draftsmen and designers consider dimen-

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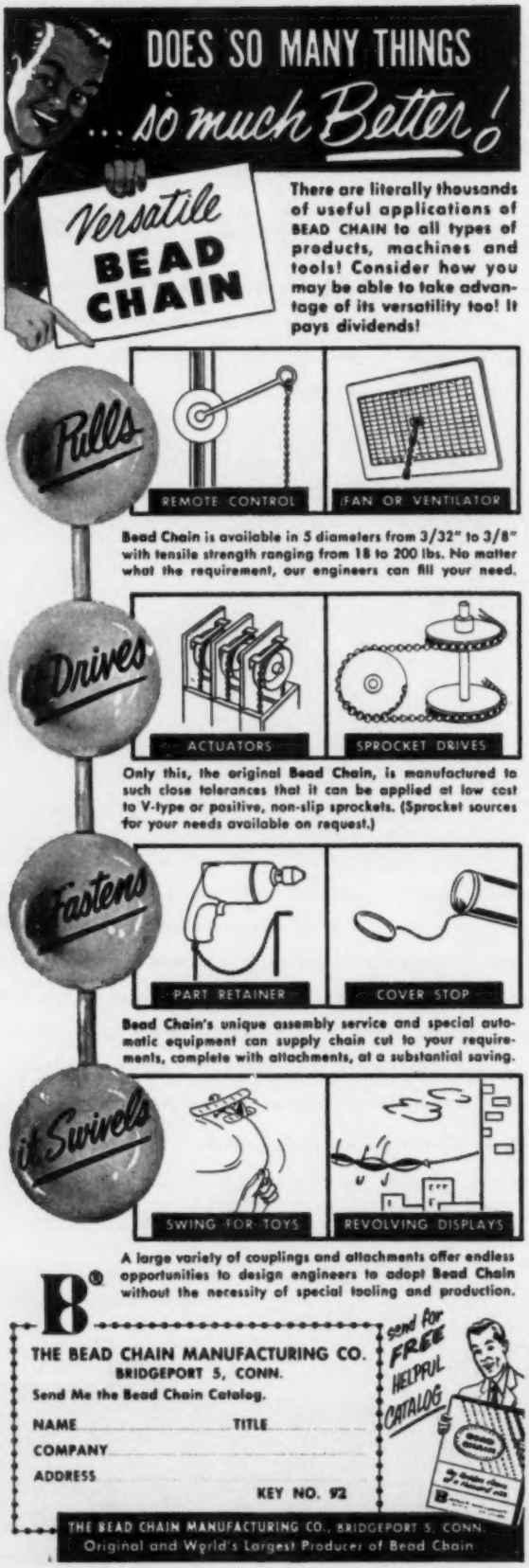
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sions only in terms of decimals and develop designs accordingly, obviating cumbersome conversions.

In a two-place decimal system, for instance, the second place decimal can be in even hundredth increments of an inch such as 0.04, 0.34 or 0.86 rather than odd hundredths like 0.03, 0.35, and 0.87, so that when divided by two, as from centerline to edge or to centerline of hole, the dimension that results will be a two-place decimal. Odd hundredths need be used only where required for design factors such as clearances and for dimensioning curved surfaces to obtain a smooth, uniform curve.

The greater simplicity of the decimal system for adding dimensions is illustrated in Table I by comparative tabulations. The first column shows a series of even two-place decimal dimensions; the second column lists a series of corresponding fractional dimensions. In the third column, fractions have been converted to decimal equivalents.

Converting the readings of measuring tools—such as micrometers, vernier calipers, or height gages, which are graduated in decimal increments of an inch—becomes unnecessary. The need of constant reference to conversion charts is obviated, reducing errors. Few draftsmen or engineers can letter the decimal equivalents of all fractions without time wasting reference to conversion charts.

Definite values and uniform interpretation are assured. The question frequently arises concerning the number of decimal places that apply when a fractional dimension is given. For instance, should $\frac{7}{16}$ be 0.4375, 0.437, 0.438, or 0.44?

Eyestrain and dimensioning errors

Table I Addition of Decimal and Fractional Dimensions

Two-Place Decimal System	Fractional System	Decimal Equivalents
0.04	1/32	0.03125
0.08	5/64	0.078125
0.12	1/8	0.125
0.58	37/64	0.578125
0.56	9/16	0.5625
0.34	11/32	0.34375
1.72	1 23/32	1.718750

are reduced in the drafting room because of the increase in distance between the $\frac{1}{64}$ graduations of the fractional scale and the $\frac{1}{50}$ (0.02) graduations on the decimal scale. The distance between the smallest graduation on the demical scale is approximately 30 percent larger.

Decimals are easy to understand such as $5.76 in the monetary system. During World War II, it was observed that trainees, particularly woman, had little difficulty in understanding the decimal system.

The dual system of dimensioning is avoided. With the fractioning system, both decimals and fractions are used, while with the decimal system it is easier to avoid overcrowding dimensions. Draftsmen can generally letter decimals such as 0.74 more neatly than fractions like $\frac{37}{64}$.

In a survey conducted by an SAE committee in 1947, a test given to a group of engineering department employees revealed that it takes approximately five times longer to add fractions than decimals. The test was repeated later at a meeting of college professors, substantiating the original observations. Assuming that an engineer, designer, checker or draftsman expends an average of approximately 10 percent of his work week in arithmetic computations involving dimensions, it has been estimated that four hours would be devoted to computations in a 40-hr week. By using the decimal system, the 80 percent savings in computation time would amount to 3.20 hr per week.

The survey further discovered that 47 organizations in the aeronautical industry were using decimal dimensioning. Considering only the engineering departments, it was assumed that an average of 200 people in each company were affected. If the time saved for each employee amounted to 3.20 hr each week, 640 hr were gained in each organization per week. For the 47 companies, 30,080 hours are saved in the industry per week. Using this figure and an assumed average salary rate of $2.00 per hr, the yearly saving is $3,128,320.

These figures represent only a small portion of the over-all savings in the industry that can be attributed to the decimal system. If it were possible to evaluate all gains resulting from use of the system, the savings could be increased a hundred fold.

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As can be seen from the exploded view, Ledex Rotary Solenoids are simply constructed with few moving parts. All parts are manufactured to exacting tolerances and are carefully inspected and assembled.

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Model Number	2	3	5	6	7	8
Diameter	1⅛"	1⅝"	1⅞"	2¼"	2¾"	3⅜"
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Weight lbs.	⅛	¼	½	1	2¼	4¼

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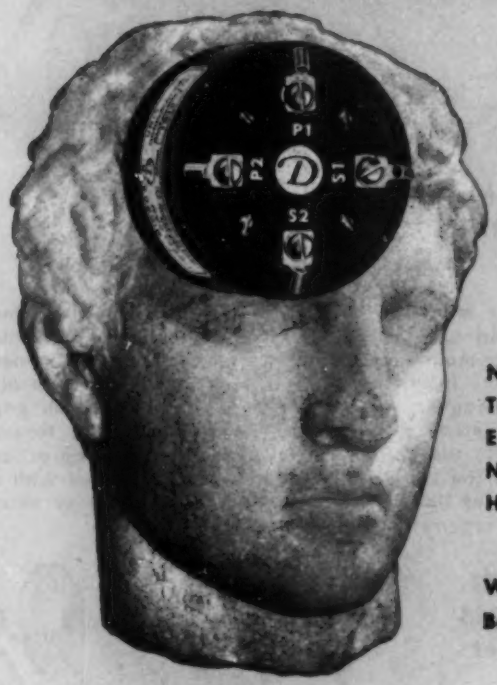

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IN INDUSTRIAL AND MILITARY applications, this small electromechanical signal generator transforms angular displacement into an electrical signal. It provides a linear output and a resolution to less than 0.01°. Tested and perfected as a standard military component for use in gyro instruments and computers, the DOELCAM Microsyn Position Indicator is now finding wide application in the industrial fields of process control, data transmission, measurement of mechanical variables and analog computation.

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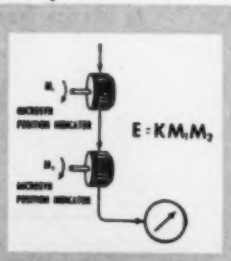

Computation

Review Your Products For Economy

REX CLEVELAND
Design-engineer;
Minneapolis Moline Co.

AFTER A COMPLEX PRODUCT has been in production for several years, it becomes more complex than ever. Such items as production machines, construction equipment, farm implements and tractors are typical examples. These products are not re-designed every year, as are automobiles, washing machines, or refrigerators. Consequently new ideas, changes and improvements are simply added to the original design.

The result of this is a general growth of the product, with little consideration being given to appearance or cost. The product gradually takes on the appearance of a "make-shift", which affects sales adversely. The total manufacturing cost is raised out of proportion to the value of the changes, making the profit margin too low. Raising the price to compensate for this reduces sales.

The solution is a periodic review of the entire product with simplification and consolidation of parts in mind. This will cut costs, improve appearance, and reinstate a margin of profit.

Recent experience on a farm tractor will illustrate how this works. It was discovered that this item had risen in cost until the profit margin was not enough to warrant manufacture. Drastic action was indicated to stop this before the high cost of building the tractor removed it from the line. Since its selling price was already greater than that of any competitor, a price rise was not possible.

A study of the product was instigated, and an exhaustive analysis of all parts was made. Both the function and design were considered; materials and labor costs were studied; and much attention was given to the increased number of parts, greater assembly time, and the variety of fasteners.

Several groups of parts had just grown, and it was found that many

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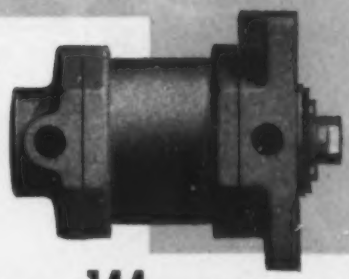

Hydraulic Valves — 144 models

Designed for 1500 P.S.I. maximum pressure, and offered for 3000 P.S.I. in most models. Four types of action: standard, spring-return, spring-centered and ball-detent. Five piston designs for any circuit. Six types of operation: hand, foot, cam, solenoid, oil pressure, and air pressure. Seven sizes: ¼", ⅜", ½", ¾", 1", 1¼", and 1½". Write for Catalog 203.

Hydraulic Power Units — 17 models

Single pump power units are offered in six tank sizes. Pump capacities range from .4 G.P.M. to 40 G.P.M. at 1000 P.S.I. Double pump power units are offered in four tank sizes with combined pump capacities ranging from 3.5 G.P.M. to 48 G.P.M. at 1000 P.S.I. 1200 P.S.I. continuous or 1500 P.S.I. intermittent pressures are available in certain models. Write for Catalog 400.

Air Cylinders — 84 models

Available for 150 P.S.I. air and 300 P.S.I. oil services. Standard models offered in seven mounting styles, nine bore diameters, in any length stroke up to 96", single or double end rod with internal or external thread, cushioned rod end, blind end, or both. Special covers supplied. Write for Catalog 55.

Air Valves — 34 models

Designed for control of air pressures up to 150 P.S.I. Offered in both 3-way and 4-way types. Available in five types of operation: hand, foot, cam, solenoid, and pilot operations; in five sizes: ¼", ⅜", ½", ¾" and 1". Pilot air valves in side and foot mountings—and in palm, push button, cam, foot, and solenoid operation. Write for catalog 303.

Dept. PE-8, RIVETT LATHE & GRINDER, Inc. Brighton 35, Boston, Massachusetts

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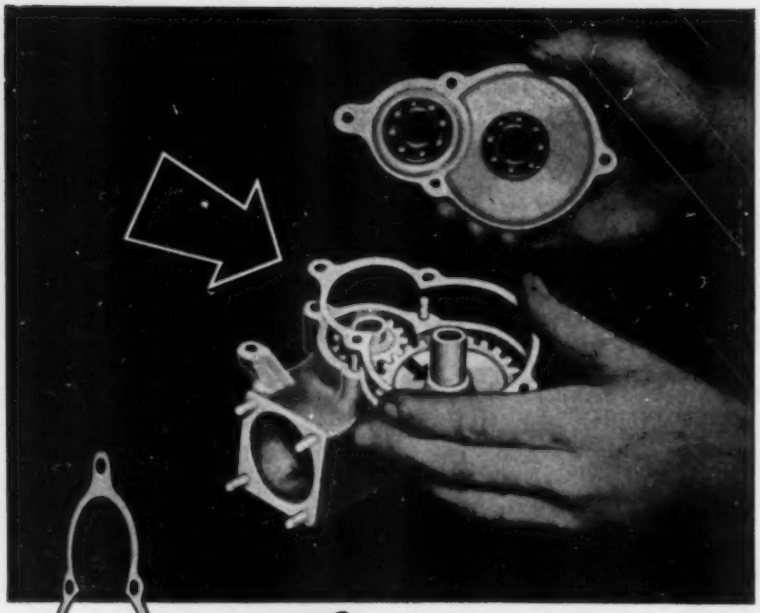

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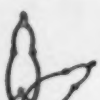
It gives wide tolerances to the thrust gear housing, saving expensive machining time.

It precisely preloads the bearing. Inner race rests on the collar, marked by arrow. Outer race is "fixed" in the housing. Removal of a .002" shim lamination brings housing and outer race closer to main assembly. This gives the minute preloading adjustment for best angular contact bearing operation.

It "takes up" after wear. Removal of additional laminations makes simple, quick adjustment.



SHIM HEADQUARTERS SINCE 1913

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were no longer necessary. Many welded assemblies were consolidated into a single casting, and with slight alteration, it was possible to reduce the cost on many others.

Parts which were purchased from outside suppliers were studied, and in many cases it was found that they could be purchased at lower cost from other venders. In some cases, buying in the next higher quantity bracket also showed greater economies.

Simple and obvious changes of materials specifications also produced cost reductions. For instance, the three sections of tubing used in the extendable wide front axle shown in Fig. 1 had always been made of seamless steel tubing. It was found that welded seam tubing of lower analysis could be used here with adequate performance curves. The seamless tubing had a cost of 40 percent more per tractor than welded seam tubing. Nothing else was involved in the change, thus the profit was increased by some $4.00.

Two light brackets used on the tractor were welded assemblies of tub-

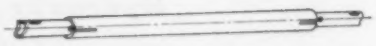

Fig. 1

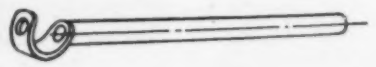

Fig. 2

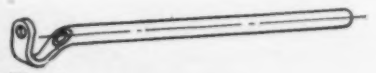

Fig. 3

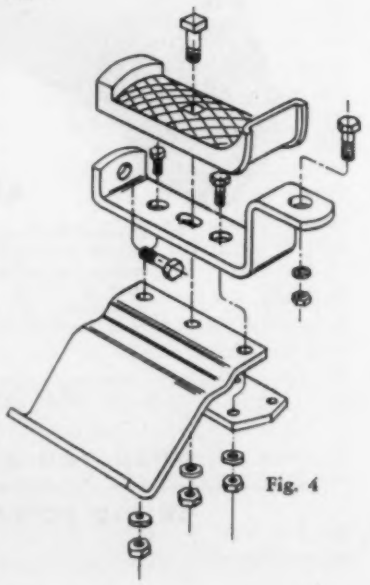

Fig. 4

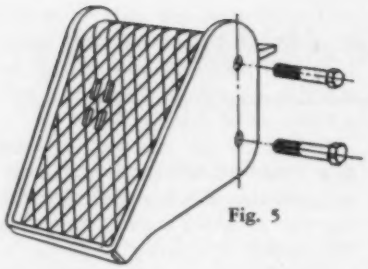

Fig. 5

ing and stamping, Fig. 2, with the greater part of the cost per tractor for these items being in the welding. Re-design of the part from tubing only, plus an inexpensive rubber grommet, cut the cost $0.56, Fig. 3.

A foot rest, Fig. 4, on each side was attached to the side frame channel with 32 parts, including fasteners, being used on each tractor. Consolidation of these parts into a casting, Fig. 5, which could be used on either side reduced the number of parts to six, saving $1.38, and resulting in a better foot rest.

The seat support, Fig. 6, consisting of 6 parts, was a high cost item due to the use of expensive forgings and a special heavy spring. Also, the adjusting mechanism lacked positive positioning. Re-design to improve performance and reduce costs brought about the support shown in Fig. 7, which is more positive and less costly, because of the use of standard fasteners and less expensive fabricated parts. Although 11 parts are used, the cost was reduced by $1.11.

Both brake pedals had been made

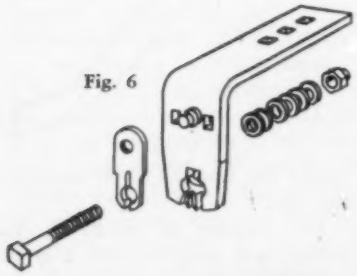

Fig. 6

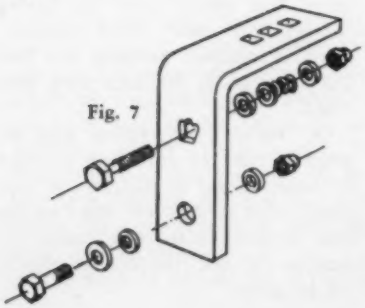

Fig. 7

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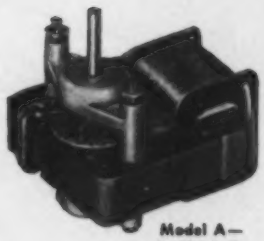

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Model O—2-pole reversible capacitor type (for 6 or 12 or 24 volt A.C. only)

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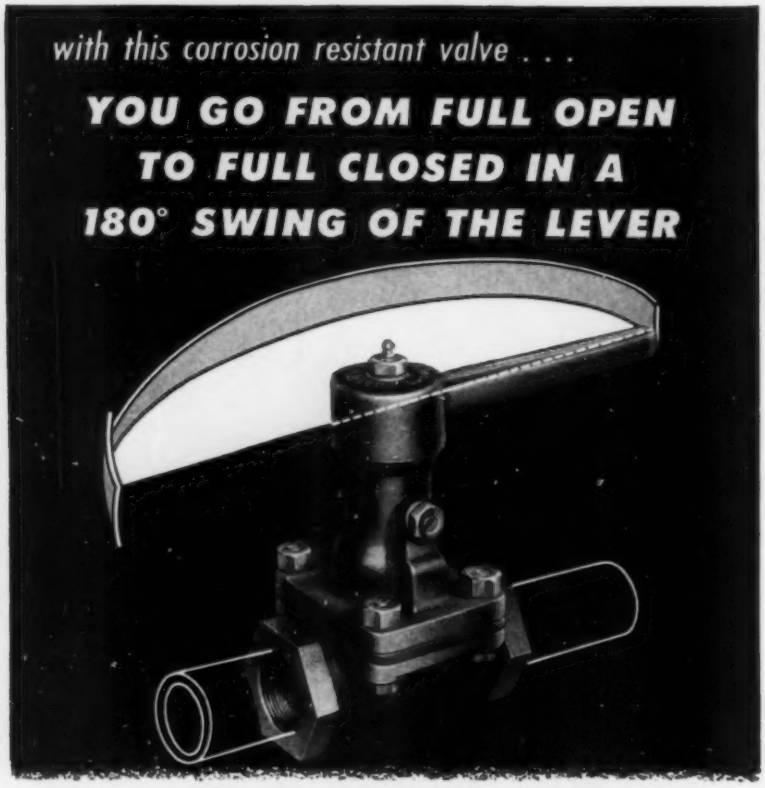

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of forged stems and pads, in welded assembly. Consolidating the assemblies into malleable iron castings resulted in a saving of 50 percent, with a better set of brake pedals.

Review of the rear step revealed that it was not only no longer necessary, but that it was actually interfering with an added feature. Removing this resulted in a saving of $1.63.

The support arm for the hydraulic lift control had previously been made as in Fig. 8, and four special parts had been required. The support arm in Fig. 9 does the job equally well, with one special part, and shows a saving of $0.65 per tractor.

Changing the location of the fuel tank outlet eliminated many parts, and $1.26 in cost. One special bolt, attached for two years after it had no

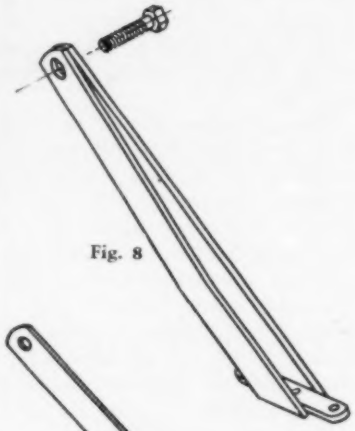

Fig. 8

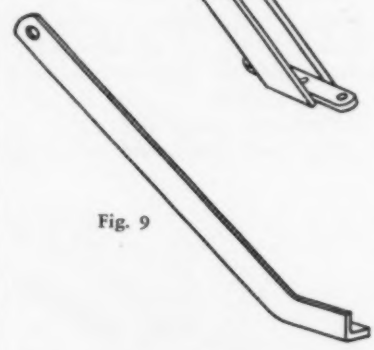

Fig. 9

further use, was still in the assembly; cost, $0.10.

The program of reviewing this product will continue, and it is believed that many more cost saving changes will result. Most manufacturers of complex products will find that they can do the same with their items.

Of course, consideration must be given to costs of re-tooling to make the changes, but if re-design is kept simple, cost savings will make up the cost of new tools in a matter of months. If not, the change should not be made.

NEW BOOKS

Measurement Techniques In Mechanical Engineering

R. J. SWEENEY, *Consulting Engineer.* *309 pages, 6 x 9 in. Published by John Wiley & Sons, Inc., 440 4th Ave., New York 16, N. Y.* $5.50.

This book gives information on the measurement techniques commonly used in performance testing of power equipment. In this field are included tests of engines, pumps, compressors, and combustion and heat-transfer apparatus. The mechanical quantities that may need to be measured include length, area, time, speed, force, pressure, temperature, and fluid flow rates. Though the mechanical engineer often has occasion to use electrical and chemical measurements, only the more common applications of these methods in mechanical engineering are discussed.

It is not intended to cover the fields of materials testing or experimental stress analysis. The discussion of instruments covers their primary function of measurement and indication, and their function as signalling devices to automatic controllers. Since prompt and accurate measurement is one of the most important factors in the accuracy of automatic control, the discussion herein is valuable to those engaged in control problems. It is often true that a slow or inaccurate primary measurement requires an elaborately complex control mechanism to overcome its shortcomings.

The data in this volume will aid two classes of readers: students and practicing engineers in development and research work. The intent is to provide an insight into the principles on which instruments are designed, and an understanding of the pitfalls to be avoided and the difficulties involved in obtaining a correct measurement of physical quantities, with the types of instruments available. No attempt has been made to give detailed descriptions of current designs of instruments, since these would be ephemeral with the progress of the art. It is believed that this plan will satisfy the requirements of both students and engineers.

The book is suitable for a text in

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introductory laboratory courses, which are primarily concerned with instruments. It will also be useful as a reference in advanced laboratory courses, wherein machines are tested. In fact, it should be possible to assign the experimental procedure, and choose the required instrumentation, with only general guidance from the instructor. The book is not intended as a laboratory manual of specific experiments, since these must be written to cover the instruments and equipment that are available in the particular laboratory and to suit the instructor's concept of the objectives of the course.

For practicing engineers, the book is a guide to the selection and use of a satisfactory instrument that will have the required accuracy, with the minimum expenditure of time and money. In most cases, methods are described for the calibration of instruments by comparison with primary standards. The sources of error due to installation are examined, and methods are outlined for the rough estimation of the possible magnitude of these errors.

The treatment presupposes a familiarity with elementary physics and calculus, such as is ordinarily given underclassmen in engineering schools. Chapters 8 and 9 covering Temperature and Flow requires a knowledge of engineering thermodynamics.

ASTM Standards on Plastics

6 x 9 in., 705 pp. Published by the American Society For Testing Materials, 1916 Race St., Phila. 3, Pa. $5.25.

This book gives a large number of standards, including specifications, definitions and tests for a wide range of plastics. Most of the 125 standards which are included have been developed through the work of ASTM Committee D-20 on Plastics. The Committee for many years has been perfecting methods of testing, and those included are considered to be the best available at this time. In addition to the standards covered by Committee D-20, there are a number that are pertinent from other fields, including electrical insulation.

The 27 specifications cover quite a wide range of molding compounds such as phenolic, polystyrene, melamines, ureas, cellulose, acetates, vinyl,

chloride, methacrylate, and materials made from these compounds in the form of sheets, rods, tubes and shapes.

The large number of test methods are arranged in the following classifications: Strength properties; hardness properties; thermal properties; optical properties; permanence properties; analytical methods for plastics; molds and molding processes for plastics; conditioning of plastics; plates, sheets, tubes, rods, and molded materials; and electrical tests. Other section headings in the book include: definitions and nomenclature; conditioning of plastics; miscellaneous subjects and appendices. The book includes a Table of Contents by subjects, and another listing the standards in their numeric sequence.

Gas Turbine Analysis and Practice

BURGESS H. JENNINGS, *Prof. and Chairman, Dept. of Mech. Eng., and* WILLARD L. ROGERS, *Asst. Prof. of Mech. Eng., The Technological Institute, Northwestern Univ.* 6 x 9 *in.*, 487 *pp. Published by the McGraw-Hill Book Co.*, 330 *W.* 42*nd St., New York* 36, *N. Y.* $8.50.

This is a concise book with a balanced coverage of the points of view of thermodynamics and stress analysis, as well as a good coverage of present design practices which are presented with illustrative problems. It offers a general and comprehensive picture of the operational points, the place and extent of use in industry, and the probable future development of the gas turbine.

The text is directed primarily toward undergrauate and graduate engineering students, but at the same time it is complete enough to enable a reader with a good engineering background to orient himself in fundamentals, performance, and practices of the gas turbine.

After development of a sound background of engineering fundamentals, the authors apply these to specific components of the gas turbine power plant. Attention is here devoted to stresses and materials of construction in addition to the thermodynamic aspects of design.

Within the inherent limits of any text of its type, it has a fairly exten-

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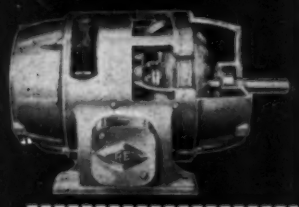

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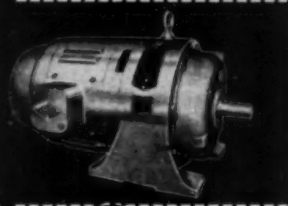

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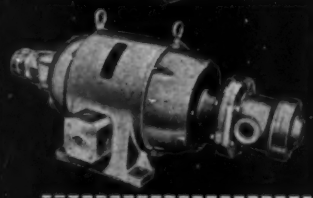

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sive treatment of design and material problems. Also, considerable space and effort is devoted to the different types of compressors, including axial, centrifugal and displacement types.

The chapters on stresses in turbine elements and vibration balancing, including modes of vibration, are unusually comprehensive.

Fuels, combustion and combustion chambers are also discussed in some detail. Furthermore, the text includes example problems with solution for clarification of the use of the concepts and applications under discussion, as well as problems (with answers for many) for reader solution. Numerous types of gas turbine units are discussed and illustrated in detail not only in relation to aircraft propulsion, but also in connection with the gas turbine as a power unit. The complete Air Tables and Combustion Gas Charts make the book an integral unit.

ASTM Standards on Copper and Copper Alloys

6 x 9 in., 556 pp. Published by the American Society for Testing Materials, 1916 *Race St., Phila.* 3, *Pa.* $5.65.

This book brings together all of the current ASTM Standards pertaining to copper and copper alloys, which were developed by Committee B-5 on Copper and Copper Alloys, Cast and Wrought, and other ASTM technical committees. It is the direct result of the close cooperation of the technical representatives of leading producers and consumers of copper and copper alloys serving on these committees. There is a wealth of data in this compact volume.

The 1953 edition includes 115 widely used standards, including 102 specifications; 9 tests methods; 2 recommended practices—one for tension test specimens for copper-base alloys for sand castings, the other for designating significant places in specified limiting values; and 2 classifications —one for cast copper-base alloys, the other of copper. A high percentage of the material included in the earlier edition has been revised and four of the methods are new.

Standards cover copper, copper alloy, and copper covered steel electrical conductors; non-ferrous metal; plate,

sheet, strip, and rolled bar; rod, bar, and shapes; wire; pipe and tube; ingot; sand and die castings; filler metal; and methods of test for copper and copper alloys.

A group of specifications cover nonferrous metals such as slab zinc; pig lead; nickel; phosphor; silicon; electrolytic cathode copper, and others. Also included are test methods covering expansion; mercurous nitrate; resistivity; preparation of micrographs; tension; hardness; sampling; and grain size evaluation. An extensive Index is included to provide a ready reference.

Plastics

442 *pp*, 6¼ x 9¾ *in., Published by Her Majesty's Stationery Office, obtainable from British Information Services,* 30 *Rockefeller Plaza, New York* 20, *N. Y.* $8.

This book, Volume I, is the first in a series of Selected British Government Research Reports issued by the Ministry of Supply. Twenty-one reports are included in the volume. Among the subjects covered in these reports are: Mechanical properties of high polymers; plasticizer-polymer interaction; absorption of water by high polymeric materials; linear shrinkage of phenolic moldings under continuous high temperature service; setting process of phenol-formaldehyde resins; ductility of plastic materials; effects of humidity on thermoplastics; variation in strength of nominally identical phenol-formaldehyde moldings; directional strength and stiffness of fibrous materials; microscopic examination of reinforced synthetic resins; and strength of bolted joints in acrylic sheet. In addition to experimental details and discussions of results, each report contains an abstract, table of contents, list of illustrations, and bibliography.

Refractory Hard Metals

DR. PAUL SCHWARZKOPF *and* DR. RICHARD KIEFFER 6 x 9 *in.*, 447 *pp. Published by the MacMillan Company, 60 Fifth Ave., New York* 11, *N. Y.* $10.

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volume is twenty years old. Also, in view of the recent developments requiring materials with substantial increases in strength and service temperatures, engineering interest is increasingly focused on the high melting carbides, borides, nitrides, and silicides. In the high temperature field, especially, much research is already being devoted to these materials because their basically different structure permits uses that cannot be achieved by mere modification or improvement of currently used alloys.

For all such research this book will be valuable. It presents full and up-to-date information on the structure, preparation, and properties of the carbides, borides, nitrides, and silicides. More than that, it presents a critical evaluation, by leading authorities, of these basic costituents of the hard metals, and a comparison of the performance of cemented (metal-bonded) products in the field of turbine bucket and other high-temperature applications as well as a complete discussion of refractory hard metals. It will be an important aid to metallurgists, inorganic chemists, and other working on the development of materials for new engineering uses.

The production and applications of cemented hard metals—eccentially cemented carbides—will be treated in a separate volume that is currently in preparation.

ASTM Standards on Electrical Insulating Materials

6 x 9 *in.*, 590 *pp. Published by the American Society for Testing Materials.* 1916 *Race St., Phila.* 3, *Pa.* $5.25.

This 1953 edition contains, in their latest approved form, 75 widely used ASTM Standards, including 56 test methods; 16 specifications; 2 recommended practices—one for the purchase of uninhibited mineral oil for use in transformers and in oil circuit breakers, the other for maintaining constant relative humidity by means of aqueous solutions, and a list of definitions with procedures relating to conditions and weathering.

Standards cover: insulating shellac and varnish; plates, sheets, tubes, rods, and molded materials; mineral oils

for electrical insulation; ceramic products (glass, porcelain, steatite); solid filling and treating compounds; insulating fabrics; insulating papers; mica products; electrical tests; servicing units and conditioning methods; plastics for electrical insulation; rubber tape and electrical protective equipment; textile materials for electrical insulation; and general test methods.

Appendices cover signifiance of tests of electrical insulating materials, and proposed recommendations for writing statements as to the usefulness of tests of electrical insulating materials.

An important innovation is the use of Bible paper which provides a substantial reduction in the bulk of the book thereby assuring a compact volume of convenient size. An easily usable table of contents is included (by subject and ASTM serial designation), and an extensive index.

Low Temperature Physics

CHARLES F. SQUIRE, *Prof. of Physics, The Rice Institute.* 6 x 9 *in.*, 244 *pp. Published by the McGraw-Hill Book Co.*, 330 *W. 42nd St., New York* 36, *N. Y.* $6.50.

Included here are descriptions of the physical properties of matter at extremely low temperatures, together with experimental results which show the obedience of these properties to quantum laws. The book furnishes an excellent background for the understanding of current papers on low temperature physics and chemistry, and will act as a stimulant to low temperature theoretical and experimental research. Because the experimental methods are results are so very close to the theoretical concepts, the book stands as an excellent blending of the two. It also includes many important unsolved problems of a fundamental nature, especially in relations to superconductivity.

The major portion of the material presented is new, having appeared in the scientific field only since World War II.

Classical experiments in American and European laboratories are also presented and given their full scale of importance.

Presentation of each subject begins from well known fundamental principles and considerable use of examples and analogies to simple sys-

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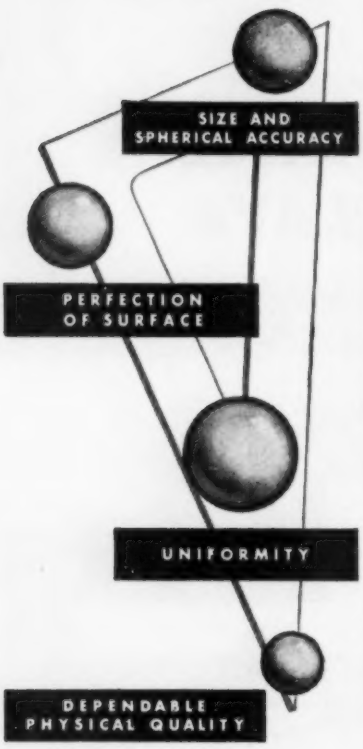

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The recent advances in technical methods for production of low temperature are given, along with the presentation of a simple theoretical analysis with each method. Descriptions of recent experiments on the properties of matter are made, including quantum characteristic properties of gaseous and liquid helium, the behavior of superconductors, and the electromagnetic permeabilities of matter at low temperatures.

Direct and graphical in treatment, the book attempts to be objectively impartial in selection of essential fact, and rigorous in theory.

Aluminum in Iron and Steel

SAMUEL L. CASE, *Battelle Memorial Institute and* KENT R. VAN HORN, *Aluminum Company of America. 6 x 9 in., 478 pp. Published for The Engineering Foundation by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $8.50.

This book embodies the type of exhaustive, critical review of research that sets the pattern for five subsequent books that will make up this monograph series. The major role assumed by aluminum in modern ferrous metallurgy makes this first volume in the new series timely.

The first part contains a summary of data showing the favorable effect of small additions of aluminum—small for individual heats, but large if the total tonnage of killed steel is considered—when added to molten steel as a deoxidizer.

The second part of this book presents a correlation of data on the effect of aluminum as an alloying element in steel. Comparatively small tonnages of this element have been used for some time as an important constituent in heat-resisting alloys, in magnet alloys, and in steels for nitriding. In these materials, which constitute a valuable class of ferrous alloys, the advantages of aluminum are widely recognized.

Chapter headings are as follows: The Deoxidation of Steel by Aluminum; Oxide Inclusions in Steel Deoxidized with Aluminum; Sulphide and Nitride Inclusions in Steel Deoxidized with Aluminum; The Role

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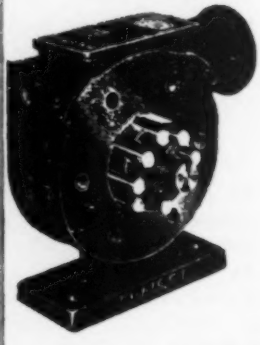

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of Aluminum in Austenitic Grain-Size Control; Effect of Aluminum on Notch Sensitivity and Related Properties of Steel; Effect of Aluminum on Aging of Steel; Some Other Consequences of the Use of Aluminum as a Deoxidizer; The Constitution of Binary and Complex Iron-Aluminum Alloys; The Manufacture of the Simple and Complex Iron-Aluminum Alloys; Aluminum in Heat-Resisting Alloys; Aluminum in Permanent-Magnet Alloys; The Function of Aluminum in Nitriding Steels; The Aluminum Coating of Steel; and Miscellaneous Uses of Aluminum as an Alloying Element in Iron and Steel.

Handbook of Noise Measurement

LEO L. BERANCK, *Technical Director of Acoustics Lab., Massachusetts Institute of Technology.* 8½ x 11 *in.*, 120 *pp. Published by General Radio Co., Cambridge* 39, *Mass.* $1.

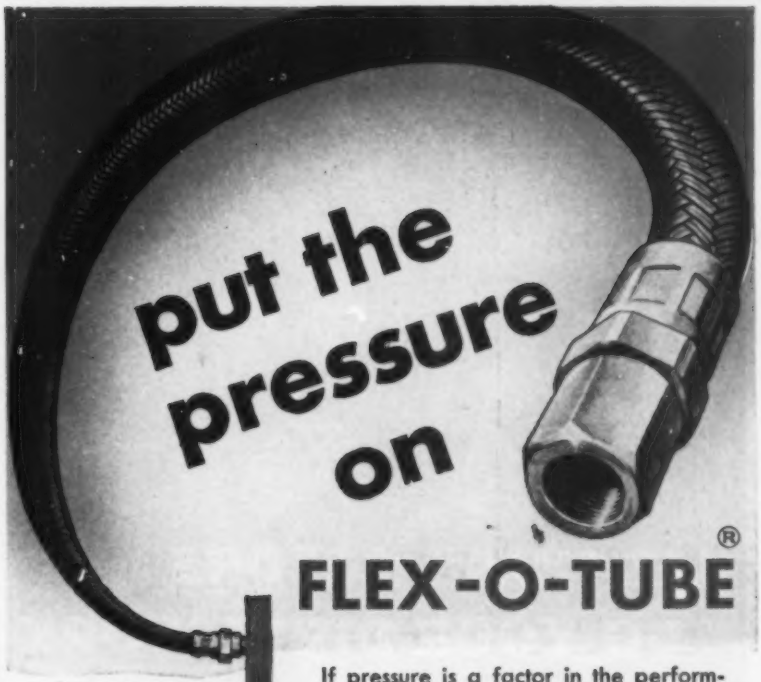
The purpose of this booklet is to help those who are faced with the necessity of making sound and noise measurements. It attempts to clarify the terminology and definitions that are used and to describe the measuring instruments and their use, to aid the prospective user in selecting the proper equipment for the measurement he must make, and to show how these measurements can be interpreted to solve typical problems.

The content of the book is as follows: Chapter I Introduction, II The Decibel—What Is It?, III The Mechanism Of Hearing As A Noise-Measuring Instrument, IV Description Of The General Radio Sound-Measuring System, V Applications For The General Radio Sound-Measuring System, VI Measurement Of Sound Level And Sound-Pressure Level, VII Loudness, Speech Interference, And Hearing Damage, VIII Noise Source Characteristics, IX Noise Control.

Top-Management and Research

PHILIP R. MARVIN, *Vice President, Commonwealth Engineering.* 120 *pp*, 5 x 8 *in. Published by Research Press, Inc., Dayton, Ohio.* $5.

An extremely iteresting and valuable feature of this short book is the great number of case examples and



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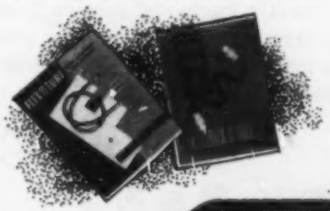

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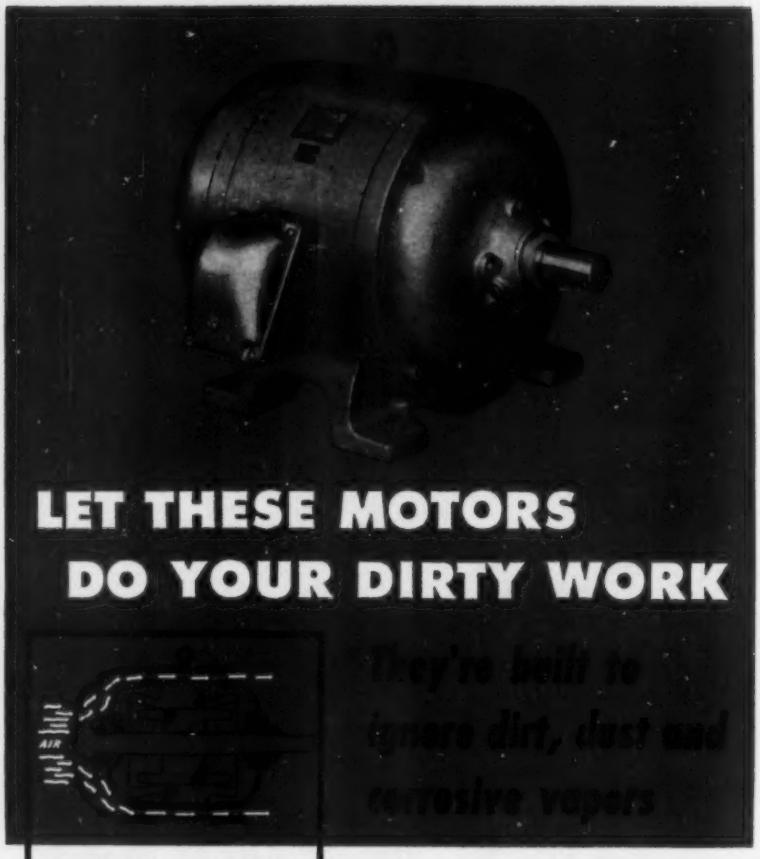

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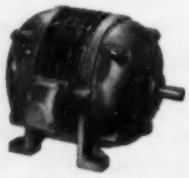

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research experiences cited. Typical of the tables included are "Composition of Departmental Representation Active in the Selection of Research Projects", being the results of a study covering 120 firms; "Research Expenditures in the Chemical Industry, 1950", giving the dollars sales and research expenditures of eleven leading companies.

Scattered throughout the book are many data on numbers of patents issued to various companies, relation of research expenditures to gross sales, savings effected by research, and similar figures. Considerable space is given to a discussion of the problem of determining whether or ot a given project is to be undertaken, and whether or not a given company is justified in conducting industrial research.

The last chapter of the book deals with "Research Contracting". The position of the contracting research firms is explained and the question, "Why and when should research projects be assigned to independent research organizations?", is discussed and cost figures cited.

Metal Machining

LAWRENCE E. DOYLE, *Assoc. Prof. of Mechanical Engineering, University of Illinois.* 6 x 9 *in.*, 511 *pp. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York* 11, *N. Y.* $10.

Completely original in its approach, this new book is a thorough and comprehensive introduction to metal machining and process planning for neophite and experienced engineer alike. It contains well-written descriptions of the equipment, method and techniques involved. Process planning is discussed in relation to each topic to give a clear picture of the significance and application of the machining as well as of the operation itself.

Common machine tools and operations are taken up in logical sequence, beginning with a concise presentation of dimensions, tolerances, and gages. The rest of the contents includes the following: Cutting Tools and Their Actions; Lathes; Lathe Operations; Screw Threads and Screw Cutting; Process Planning; Shapers; Planers; Drilling Machines and Operations; Milling Machines and Operations; Milling Machines and Cutters; Milling Attachments and Operations; Bor-

ing Machines and Operations; Sawing and Filing; Broaching Machines and Broaches; Grinding Machines; Abrasives, Grinding Wheels and Operations; Surface Finishing Operations (Lapping, Honing, Superfinishing, Polishing, Buffing and Tumbling); Gears and Gear Making; and Turret Lathes and Automatics.

Basic Mechanics of Fluids

HUNTER ROUSE, *Prof. of Fluid Mechanics and Director Iowa Institute of Hydraulic Research, and* J. W. HOWE, *Prof. and Head of Dep't of Mechanics and Hydraulics, State Univ. of Iowa.* 6 x 9 *in.*, 245 *pp. Published by John Wiley & Sons, 440 Fourth Ave., New York* 16, *N. Y.* $4.50.

Intended to provide a fundamental basis of the mechanics of fluids for all types of engineers, this book presents material that not only is basically sound, but also is directly useful. It approaches the subject from the mechanics point of view at all times. In brief, the basic principles of kinematics and dynamics are applied to the elementary motion of a fluid, and the effect of each essential fluid property is studied in turn. A constant effort was made toward the realization of general methods of analysis rather than procedures for solving specific problems.

The ten chapters are headed:

Introduction; Fluid Statics; Fluid Kinematics; Fluid Dynamics; Effects of Fluid Weight; Effects of Fluid Viscosity; Resistance to Turbulent Flow in Conducts; Resistance to Flow Past Immersed Bodies; Lift and Propulsion; Effects of Fluid Compressibility.

Fire Prevention and Protection Fundamentals

GILBERT E. STECHER, *New York University.* 6 x 9 *in.*, 744 *pp. Published by The Spectator, Chestnut and 56th Sts., Philadelphia* 39, *Pa.* $10.

Although primarily intended for readers directly associated with Fire Protection Engineering, this book has a considerable amount of data that will be of interest and value to design engineers. For example, in Chapter 6 which deals with fire producing phenomena, the author discusses friction and lubrication—as they tend to cause fires.

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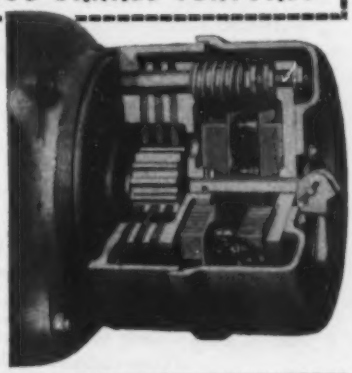

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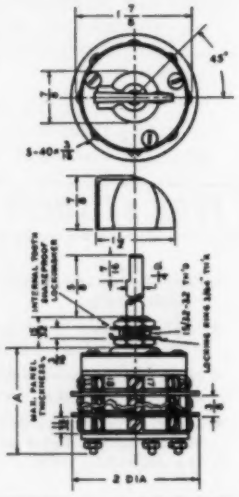

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Design of Machine Elements

M. F. SPOTTS, *Prof. of Mechanical Engineering, The Technological Institute, Northwestern Univ.* 6 x 9 *in.*, 504 *pp. Published by Prentice-Hall Inc., 70 Fifth Ave., New York* 11, *N. Y.* $9.65.

This second edition of a popular text has been expanded and brought up to date by the addition of several new topics. Among the changes are:

1. The chapter on working stresses has been expanded to include methods for both static and fluctuating loads applied to brittle as well as ductile materials.

2. Data on torsion has been collected into a chapter on shafting. Additions include sections on bending loads in two planes, shaft on three supports, critical speed of rotating shaft, slope of shaft by elastic energy.

3. Data on standard-size spring wire have been included as well as equations for designing rubber spring.

4. Unified thread information was added to the chapter on screws.

5. Chapter on lubrication now includes data for the design of partial journal bearings of various size arcs.

6. Methods for determining the gears of a train of specified ratio are included but material previously given on the extened center distance method has been deleted.

7. Chapters on bevel, worm and helical gears and cams have been rewritten.

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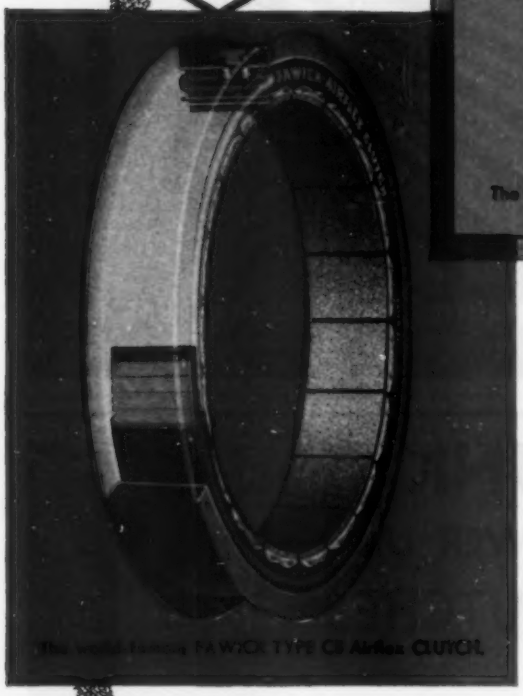

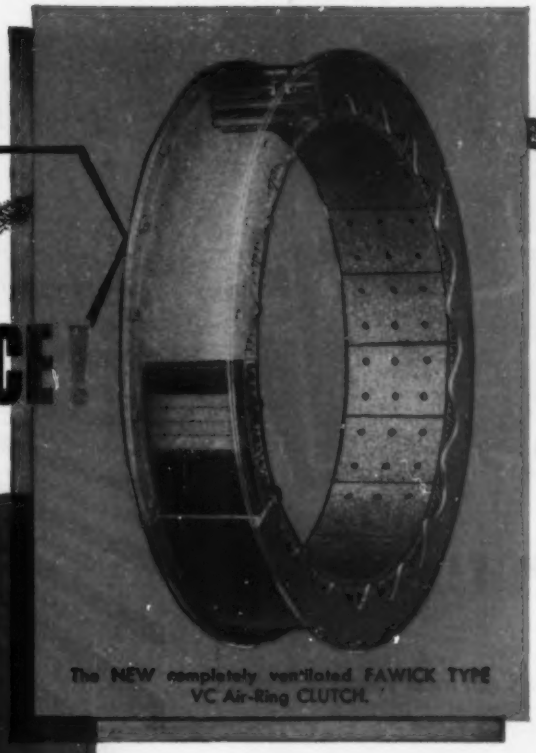

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Through continuous research, rigid quality control and over 150 years of manufacturing experience, Scaife Company is well fitted to develop top-flight pressure vessels in the quantities needed to supply your production line.

Whether you require water heater tanks, ASME, or other code or non-code pressure vessels, you'll find Scaife Engineering skill and ingenuity can provide the answers to your problems.

TYPICAL USES FOR SCAIFE PRESSURE VESSELS

- Tanks for Air Compressors
- Tanks for Railroad Cars
- Tanks for Water Heaters
- Diesel Engine Starting Tanks
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- Hydro-Pneumatic Tanks for Well Pump Systems
- Domestic Water Purification Tanks
- Gas Cylinders and Tanks (ICC and ASME)
- Tanks for the Plumbing Industry

May we send you more detailed information on Scaife pressure vessels? Write: Sales Department, Scaife Company, 26 Ann Street, Oakmont (Pittsburgh District), Pennsylvania.

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This right angle drive and heavy-duty clutch unit is only one of many engineered and manufactured by FUNK. There are types and styles to fit almost any requirement for shaft speed and installation space. They are designed to fit any standard SAE flywheel housing or Ford Industrial Engine. Our engineers will be glad to work with you on any special power problem.

FUNK Products Include:

- Straight Power Take-Off Clutches
- Gear Reduction Take-Offs
- Right-Angle Take-Offs
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- Jack Shaft Extensions
- Ford Tractor Conversion Kit, changes to 6 or V-8 engines, doubles the power at 1/3 the cost.

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From spindle to spindle—a strong, one-piece forged axle.
Torsion spring engineered to each rated capacity; one end anchored to axle, the other to mounting bracket.
Bracket contains renewable friction bearing insert.

To the designer and builder of towed equipment . . .

Here's the NEW RIDE you've been looking for!

There's just nothing else like it . . . the superior ride made possible by the ASF-Linco "Level-Load" Axle. Here's a completely new principle of axle and springing design . . . *and it accomplishes just what the name implies!*

Keeps the load level—and lower

It can't be any other way. Weight of off-center load is evenly distributed on *both* springs. That—plus the low center of gravity permitted by the axle design—means no tilting or swaying . . . better tracking . . . and an even pull on the drawbar.

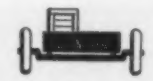
Cushions shocks—adjusts spring tension automatically

Both springs—and both spindle arms—always act together. Spring tension automatically varies itself to meet road conditions and weight of load. Under light loads, spindle arm is horizontal; as load increases, the arm moves up, reducing leverage. The result is higher payload capacity than any other similarly rated axle!

Adds new features to towed equipment

Level, stable riding and tracking of towed equipment—without tilt or sidesway—are features that can help you attract and sell customers. Write for information on towing at its level best! American Steel Foundries, Automotive Division, 410 North Michigan Avenue, Chicago 11.

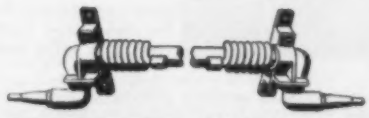
The first major axle development in 50 years!



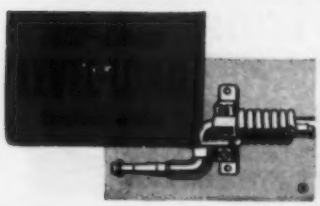
Under load, relative position of axle and body is unchanged. Both springs take load evenly.

Light load gets full spring action because long leverage absorbs road shocks efficiently.

Full load reduces leverage, which automatically balances the spring to load requirements.



Completely assembled—ready to mount with just 4 bolts! Mount it in minutes to trailer frame, or directly to equipment such as compressors, welding machines, mixers, etc. No equalizing bars needed in tandem mounting.



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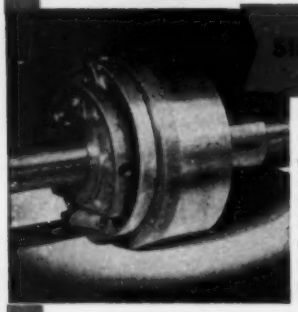

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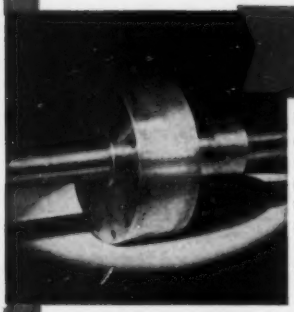
Unequaled for accurate control of intermittent machine operations—cutting, punching and packaging. Gives closer tolerances to cut-off, stamping, shearing and similar machines. Completely automatic; manual, mechanical or electrical control.



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They're Light

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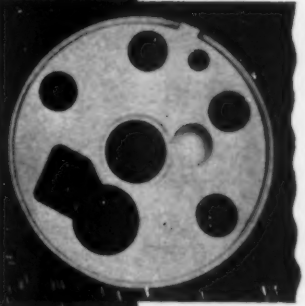

They're Highly Versatile

Glass Fiber Mat Molding forms radar cover 51" in diameter. Complex shape achieved without hand work or punch press.

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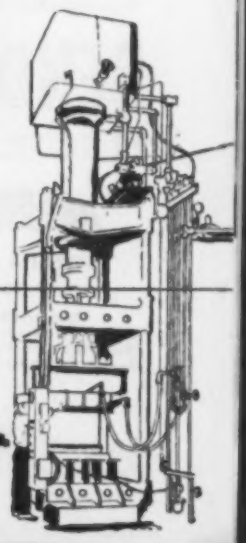
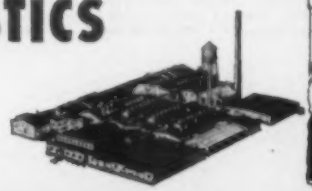
Molded Reinforced Plastics such as AICO #100 are non-conductive to electrical current . . . offer extreme heat and flame resistance. In addition to being light, strong and adaptable, Molded Reinforced Plastics are highly resistant to the deteriorating effects of weathering, oils and acids. That's why they can do jobs no other materials can handle . . . cut finishing and fabricating costs without reducing product quality. For all the facts on "What You Should Know About Molded Reinforced Plastics" . . . mail coupon for your free copy of this valuable booklet today.

A Complete Molding Service

AICO's complete plastic molding service includes: Engineering Counsel; Mold Building; Injection; Compression and Cold Molding plus the molding of Reinforced Plastics. AICO's new 100 ton press, shown in sketch, can produce reinforced plastic parts as large as 2' x 4' x 4'.



AICO plastics



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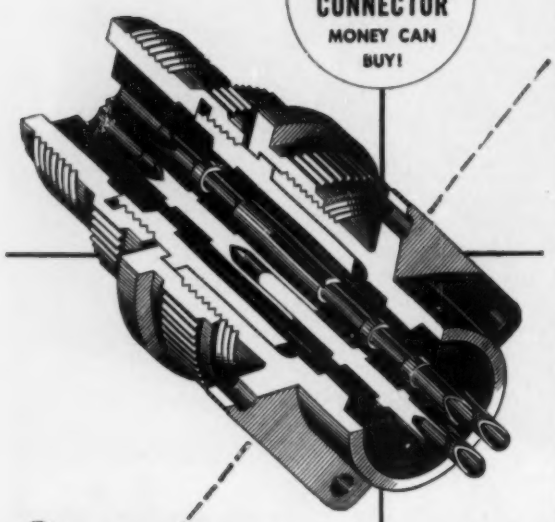

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When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of −67°F to +275°F. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

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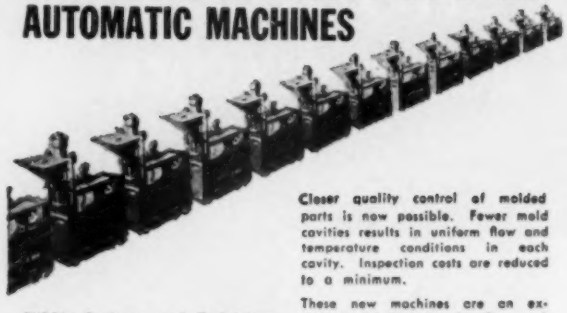
PYRO Pyro Plastics

Starting Point for a Better Product

VOLUME 1 NUMBER 4

LOWER MOLDING COSTS WITH NEW AUTOMATIC MACHINES



PYRO's Engineers and Technicians have developed new molding equipment—which reduces production costs for small parts. These machines eliminate the "human element" by operating fully automatically and are ideally adapted to both long and short run production. Such high speed operation eliminates the need for large, expensive multi-cavity molds. Thus, mold costs are lower too.

Closer quality control of molded parts is now possible. Fewer mold cavities results in uniform flow and temperature conditions in each cavity. Inspection costs are reduced to a minimum.

These new machines are an exclusive development by Pyro. A large battery stands ready to serve you.

Investigate now! Send your part designs and complete information to PYRO for prompt, money-saving quotations. Complete injection molding services under one roof: Product Design and Development, Engineering and Tooling, Production and Assembling. Why pay more than necessary? It will pay you to check with PYRO.

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Protect Your Machinery with LOVEJOY FLEXIBLE COUPLINGS

CUSHIONS FOR EVERY DUTY 1/6 TO 2500 HP.

Instantly and permanently correct misalignment . . . absorb vibration, shock, backlash and surge . . . protect motor and driven machine . . . improve production. Cushions changed without shutdown.

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Also Mfrs. of Lovejoy variable speed pulleys and universal joints

This crosshead is part of a rig that drills holes in the ground into which concrete is poured for foundations. Originally it was produced as a weldment—from 16 pieces of steel.

Conversion to a one-piece steel casting—through teamwork of manufacturer's engineering department and the steel foundry—cut cost of part more than 60%, and assured dependability. Greatly improved appearance was an additional benefit gained through the use of steel castings.

★ ★ ★ ★

Here is another example of the foundry cooperation which is resulting in lower costs and improved products through redesign to steel castings.

This service is offered without cost or obligation. It makes available through your foundry representative the full results of the development and research program carried on by the Steel Founders' Society of America.

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Design and Build With Steel Castings

Announcing–the new LPD design **Clipper Oil Seal**

The design of the new LPD Clipper Seal assures that the spring which controls the lip contact on the shaft will be held tightly in the seal. It further provides a husky lip section that enables better control of lip flexing, and better utilization of the full available depth of the lip section.

. . . an efficient, all-purpose seal with long life and a wide range of applications

EXHAUSTIVE FIELD TESTS and customer usage show that the new Type LPD Clipper Seal has a wider range of applications than any other oil seal design.

It provides better retention of lubricant and more thorough exclusion of dirt and abrasives. This holds true even at higher shaft speeds and despite wide equipment variables. It can be used for practically any application with greater assurance of fewer replacements.

The new Type LPD Clipper Seal runs cool and lasts longer because it requires less lubrication over its lip bearing area. Furthermore, the LPD design provides better utilization of the lip section of the seal—another factor in prolonging its life. And the greater flexibility of this lip section improves the performance of the seal.

The heel and lip compounds in which the new Type LPD Clipper Seal is available enable it to withstand a wide range of service conditions and temperatures. For more information about the new Type LPD Clipper Seal, write Johns-Manville, Box 60, New York 16, N. Y.

JM **Johns-Manville CLIPPER SEALS**

Here's *usable beauty* for exacting service . . . wear-resistant, hard, bright and strong throughout! SUPERIOR STAINLESS forms smoothly and easily because it is uniform in every physical quality: facts proved by the mile in mouldings manufacture every day. • May we serve *your* stainless steel strip applications?

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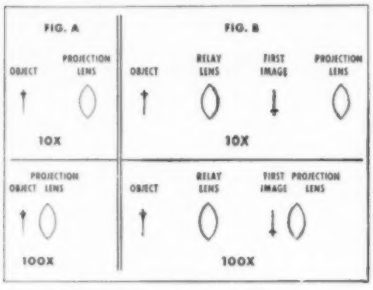
CARNEGIE, PENNSYLVANIA

(ADVERTISEMENT)

Plain Pointers on Projection

ALTHOUGH we frequently speak of magnifying an object 100× with the Kodak Contour Projector, technically we do not magnify the object at all. Instead we magnify its image, as formed by a relay lens. This relay system, diagrammed in Fig. B, forms an image of the object at a ratio of 1 to 1. The magnifying optics in turn pick up this image and enlarge it from 10 to 100 times.

Since the end result is the same—an enlarged image of a part on the screen—this might seem a roundabout system to the uninitiated. On the contrary, there are logical mathematical reasons for it. One of the more restrictive factors in conventional optical systems is expressed by the formula, M = id/od; that is, magnification equals the ratio of the image distance to the object distance. In practice, where image distance is limited, this entails using lenses of short



focal length for high magnifications. The lens is moved close to the work, decreasing object distance and unfortunately decreasing at the same time the size part which may be checked (Fig. A).

It was to overcome this limitation that our optical experts incorporated the relay system in the Kodak Contour Projector. Since this system merely images the part at unity, the focal length of the relay lens can be comparatively long—in this case eight inches. And the magnifying optics can be moved as close as desired to the image formed by the relay. As a result, users of our projector have a full eight inches in which parts may be staged, regardless of the magnification desired. This permits checking form tools, shafts, and other bulky parts.

If this were all that the relay accomplished, it would be justified design wise. However, it also makes it practical to incorporate in the projector a lens turret in which lenses of varying magnifying power may be mounted. With such a turret, magnification is changed by merely twisting a dial and the part remains in focus at the new magnification. This is a handy feature, and only one of a number of optical features of the Kodak Contour Projector to be discussed in this space.

You can inspect long parts at all magnifications ...with the Kodak Contour Projector

THIS seven-inch-long cycle timing part must be inspected for tooth contour, location and spacing of two cams, shaft diameter, shoulder spacing, and form, size, and runout of the lead screw. All these dimensions may be quickly checked on the Kodak Contour Projector. That's because the Kodak Contour Projector provides an unvarying 8″ clearance between lens and object at all magnifications. (The column at the left tells you why.)

The exceptional versatility of the Kodak Contour Projector permits this part to be completely inspected in six positions, at several different magnifications, and using both surface illumination and silhouette projection. And the job requires little training, is done quickly and easily.

Whether for toolroom use or production assembly and inspection, you'll find a Kodak Contour Projector will get the work out in a hurry. With an appropriate chart-gage and fixture you can inspect all sorts of complex parts, large and small. There is a field representative in your area who will answer your questions. To get in touch with him, or for a copy of a new booklet, "Kodak Contour Projector," write to:

Special Products Sales Division
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Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

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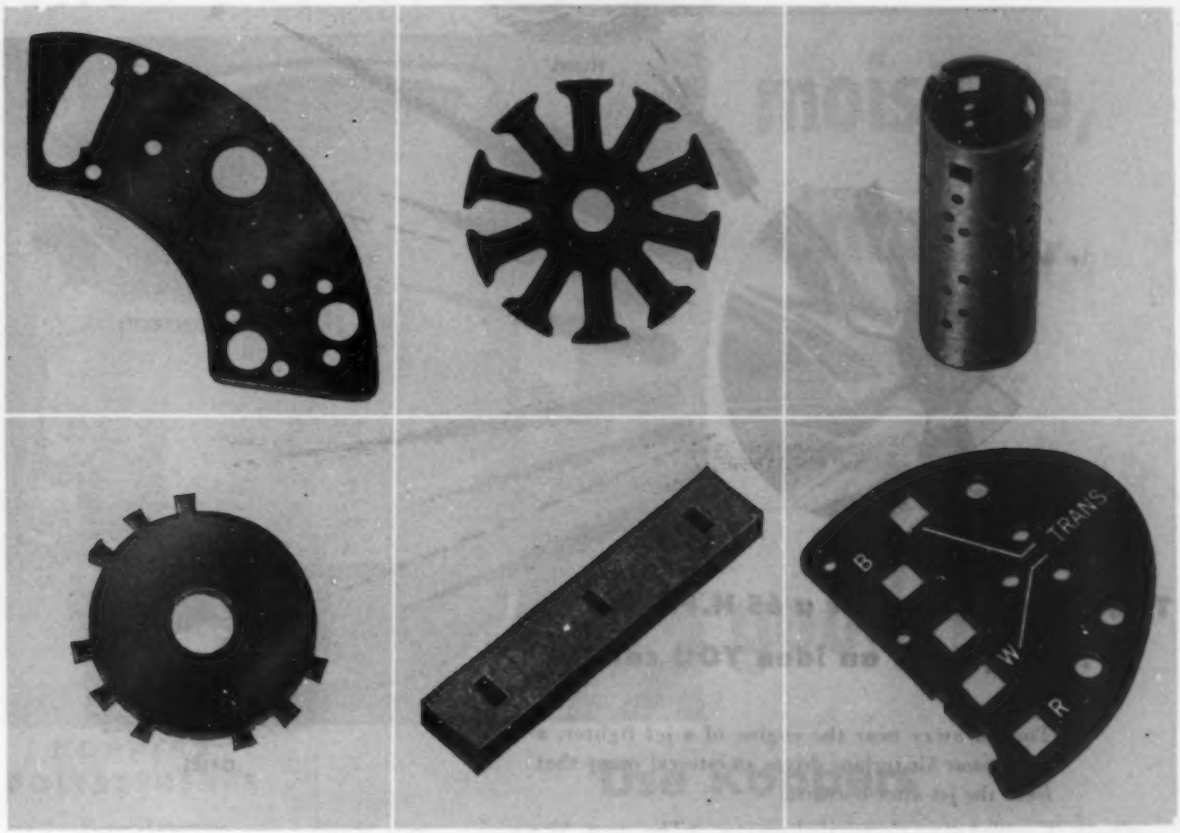
A new sound movie, Optical Gaging, shows how to simplify complex inspection problems. We'll tell you how to get it for a showing.

Kodak
TRADE-MARK

Want to punch something?



THEN LOOK at these parts . . . all punched from Taylor Vulcanized Fibre or Laminated Plastics. They are typical of the wide variety of shapes and sizes that can be economically produced to close tolerances.

When you use Taylor Vulcanized Fibre and Laminates for your punched parts, you have a wide range of physical, electrical and mechanical properties to choose from. Vulcanized fibre can be furnished in sheets, rolls and rods . . . laminated plastics in sheets, tubes and rods. A variety of colors and finishes is available.

For switch insulation, brush holders, arc barriers, refrigerator latch gaskets, shielding, relay covers, armature slot insulation, luggage reinforcing strips, and washers . . . just to name a few applications . . . be sure and investigate the advantages of Taylor materials for making punched parts.

A Taylor Engineer will be glad to help you pick the grade of Vulcanized Fibre or Phenol, Melamine or Silicone Laminated Plastics that are best suited to your particular requirements.

Taylor Fibre Co., Norristown, Pennsylvania—La Verne, California.

TAYLOR
Laminated Plastics
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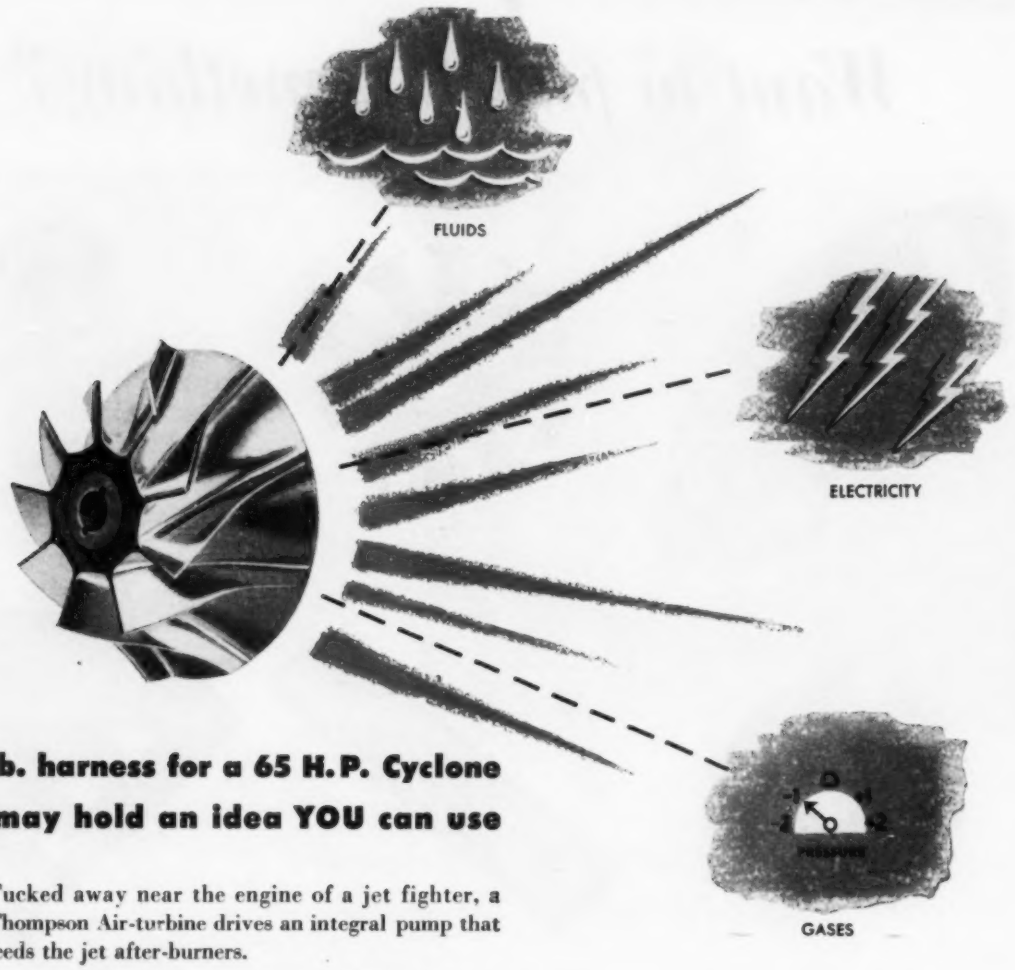

This 12 lb. harness for a 65 H.P. Cyclone ...may hold an idea YOU can use

Tucked away near the engine of a jet fighter, a Thompson Air-turbine drives an integral pump that feeds the jet after-burners.

Coupled to an electrical alternator, a Thompson Air-turbine drive delivers vast amounts of horsepower at micro-precise speed, regardless of fluctuations in load.

These Thompson turbines pack abundant power into small space, with minimum weight. What's more, they use air, always available at low cost.

Industry is discovering dozens of new uses for these Thompson Air-turbines . . . in a wide range of sizes and power. You may find it worth-while to call in a Thompson representative to tell you what we know about designing and building Air-turbines. To find out how you can put them to work in *your* application, present or future, write . . .

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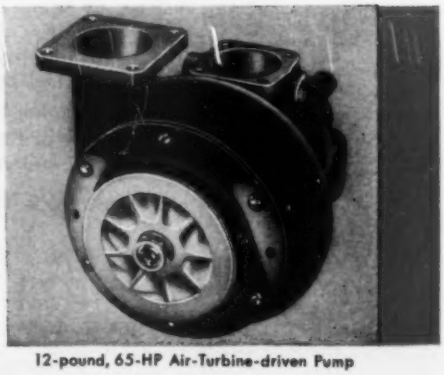
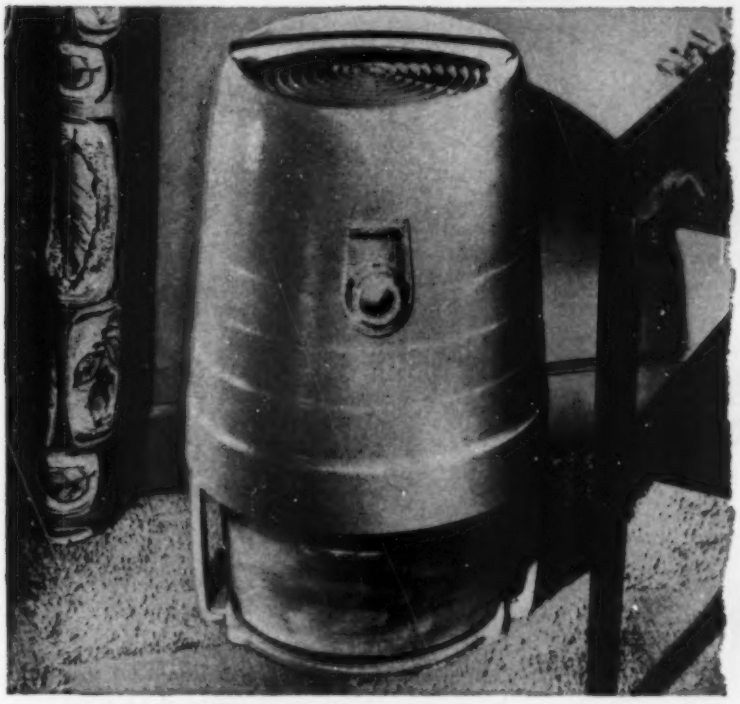


12-pound, 65-HP Air-Turbine-driven Pump

Molder: Sinko Manufacturing and Tool Co., Chicago, Ill. *Manufacturer: Admiral Corporation.*

When you need high resistance to



moisture, impact, heat, plus good looks

KOPPERS POLYSTYRENES

Type 3	General Purpose Polystyrene
Type 7	Improved Heat Distortion Temperature
Type 8	Highest Heat Distortion Temperature
MC-185	High Impact, Lowest Water Absorption Rate
MC-301	High Impact, Improved Heat Distortion Temperature
MC-305	High Impact, Easy Flow
MC-309	High Impact, Highest Heat Distortion Temperature
MC-401	Medium Impact, Improved Heat Distortion Temperature
MC-405	Medium Impact, Easy Flow
MC-409	Medium Impact, Highest Heat Distortion Temperature

Use Koppers Modified Polystyrene MC-309

A moisture conditioner housing must be good looking because it is exposed to view like any article of furniture. It must remain unaffected in extremely humid atmospheres . . . and it must be tough enough to withstand the ordinary jars and shocks that are met in living room use. Additional utility—in the form of extra heat resistance—must be engineered into this appliance.

Koppers MC-309 Polystyrene fills all these requirements. The housing shown is grained to resemble wood and presents a handsome appearance. Experience has proved that the high resistance of MC-309 to moisture, impact and heat has been completely satisfactory.

For the molder, MC-309 has the additional advantage of easy moldability. The 4 lb. shot necessary to form this housing flowed readily to give a minimum cycle.

Contact Koppers today for information about the polystyrene best suited for your product. Among the wide range of Koppers Regular and Modified Polystyrenes, there is one that will help you to improve product quality or lower your production costs.

Koppers Plastics Make Many Products Better and Many Better Products Possible.

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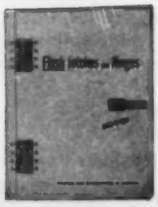
available for over 300 COMBINATIONS of door and frame thicknesses

Hartwell Trigger-action Flush Latches are produced in over 300 stock combinations of bolt and trigger offsets. We can supply a latch for any door of any thickness to be latched in a frame of any thickness to your specifications. No altering of panels and frames is necessary when Hartwell Flush Latches are installed. Offsets of bolt and trigger are stamped on each part for rapid and accurate selection of the correct latch for each installation.
All Hartwell Flush Latches and Hinges are the result of over a decade of continuous specialized design and manufacture.



Write for new Flush Latch and Hinge Catalog.

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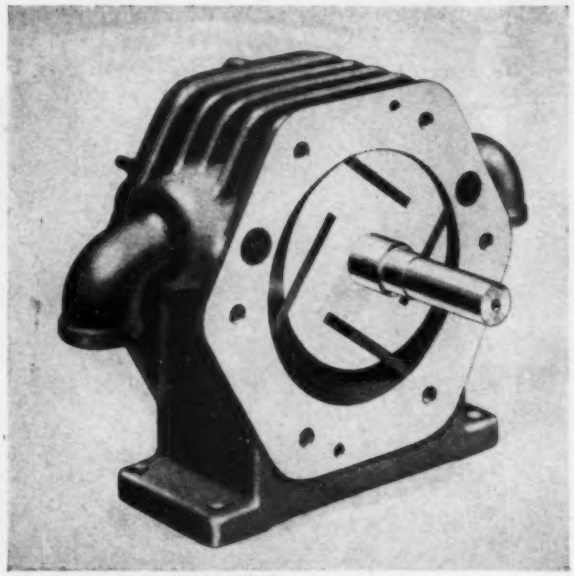
LOS ANGELES 34, CALIFORNIA

The Dexter-Conde DRI-AIR Pump providing vacuum to 20 inches . . . oil-free pressure to 12 p. s. i. *needs no lubrication!*



The Dexter-Conde DRI-AIR Pump

This pump delivers clean air, free from oil spray or mist. Its wide use by manufacturers of printing and packaging machinery* where even the slightest trace of oil could spoil the product, proves that here is a completely dependable vacuum and pressure pump.

Consider these DRI-AIR features:

- **Carbon-graphite vanes — stick-proof, warp-proof, chemically inert — provide their own lubrication**
- **Double-sealed, grease-packed New Departure ball bearings, completely removed from pump chamber**
- **No oil cups to be tended — or expensively overlooked**
- **No greasy dirt accumulations or oil pool fire hazard**
- **High efficiency increases as pump is used**
- **Runs cool — with negligible wear and long life**
- **No gaskets to leak or blow**
- **Performance unaffected by normal temperature changes**

Available in capacities of 6.2, 17.0 and 35.0 c. f. m.
Vacuum — 27.8" maximum, intermittent operation
15" to 20" steady operation
Pressure — up to 12 p. s. i.

***Including Dexter feeding, folding and binding machines**

The Dexter-Conde DRI-AIR Pump has been given a complete series of tests by the U. S. Testing Company, Hoboken, New Jersey. A copy of their report, together with further technical information, will be sent on request made to:

Dexter Folder Company
General Sales Offices
330 West 42nd Street, New York 36, N. Y.

32" long, 26" wide, 4" deep
11½" dia., 2" deep
42" long, 8" wide, 3" deep
VERSATILITY!
WHILE we, at Transue's, are known as America's foremost oil pan stamper, we have earned a reputation for quality deep drawn stampings in other fields. Business machines, food processing, agricultural machinery, and others, have gained both structural and economic benefits from an association with
Transue & Williams
Sales Offices: NEW YORK, DETROIT, CHICAGO, CLEVELAND, PHILADELPHIA, INDIANAPOLIS
14⅜" long, 10⅜" wide, 6¼" deep
12½" long, 9½" wide, 5½" deep

Serving Industry....

Wire Forming • Metal Stamping
Deep-Drawing

The complete and extensive metal manufacturing facilities of Eastern Tool & Mfg. Co., from preliminary engineering and design to final finishing, are devoted to serving the needs of industry.

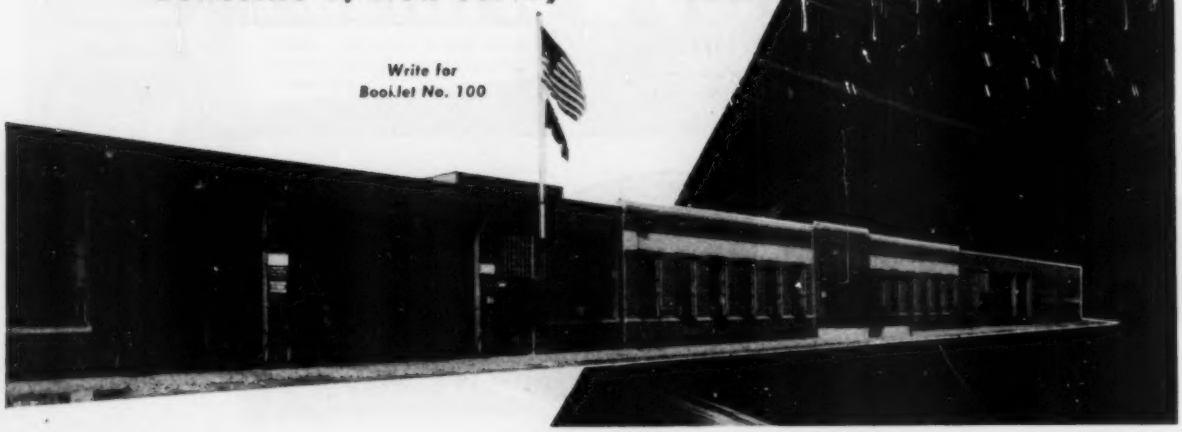
Our wire forming, metal stamping and deep-drawing divisions, capable of handling an almost infinite variety of shapes, sizes and kinds of metal, often at extremely close tolerances, are supplemented by a fully equipped plating and finishing department, all under one roof.

Eastern Tool & Mfg. Co. is truly an integrated operation, "manufacturing for other manufacturers since 1910".

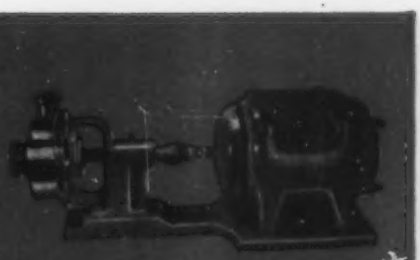
Above: Section of plating and finishing department.
Below: One of a large battery of metal stamping machines.

Eastern Tool & Mfg. Co.
Belleville 9, New Jersey

Write for Booklet No. 100

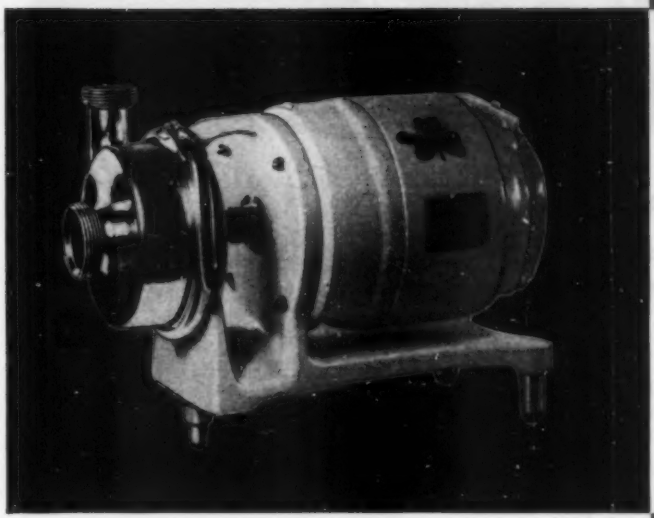


You'll find all the features you want in TRI-CLOVER PUMPS



"Standard" Sanitary Series

Designed for the non-agitating, efficient pumping of milk, food products such as diced carrots, cream style corn, tomatoes, applesauce, relish and beverages. It is also practical in breweries and for the pumping of drugs and chemicals in solution.



"Pump King" Unimount Series

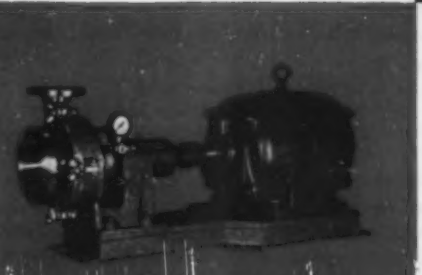
Designed for very efficient operation at 1800 and 3600 RPM, and especially where high heads are required, through heaters, coolers, filters, clarifiers, etc. The 3600 RPM model is especially applicable in the dairy industry where high head and low capacity are essential and for handling low and medium viscosity liquids in the food processing industry.

OVER 30 years of continuous improvement is embodied in today's line of Tri-Clover centrifugal pumps.

The "Pump King" Sanitary Series—the Standard Sanitary Series—and the Industrial Series—all have exclusive Tri-Clover pump features that mean better, more efficient liquid transmission.

Patented screw type impeller with sanitary impeller clip—inert carbon seal that is easily removed and cleaned—streamlined, lightweight head with a minimum number of parts—simple, fast pump assembly and disassembly with the new Ring Clamp construction—these are just a few features that make Tri-Clover Centrifugal Pumps ideally suited for food, chemical, dairy, and industrial requirements for sanitary and corrosion-resistant service.

Benefit from these important advantages when looking for a solution to your pumping problems.



"Industrial" Series

Designed for pumping latex, water, brine, light oils, chemicals, paints, lacquers, and liquids in the food processing field where lines are of I.P.S. type. This model offers quick disassembly features for ease in cleaning.

Tri-Clover®
MACHINE CO.
Kenosha, Wisconsin

See your nearest Tri-Clover distributor.

P-153

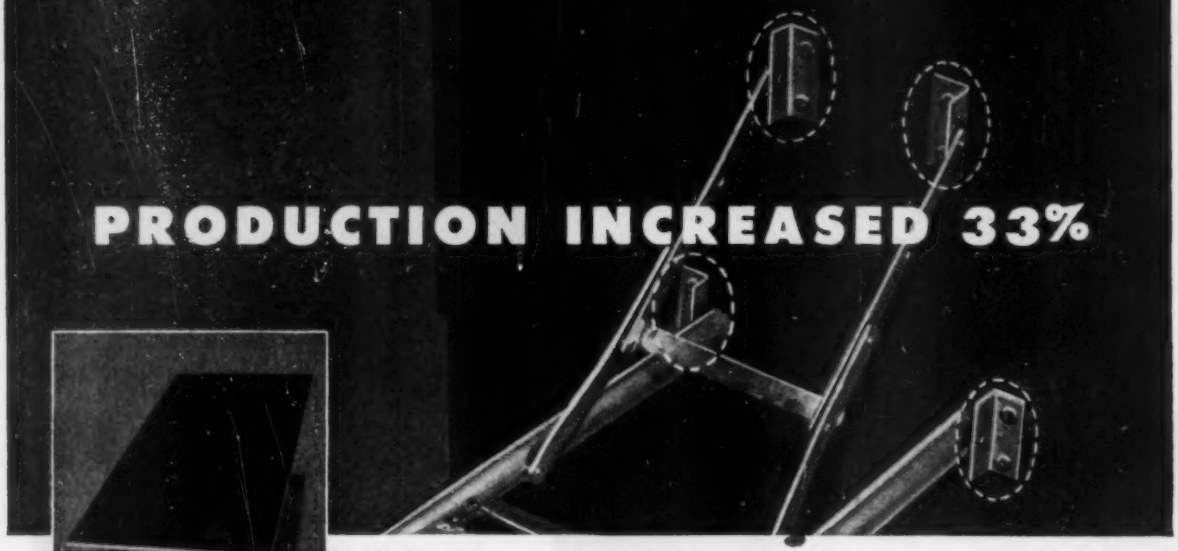
TRIALLOY AND STAINLESS STEEL SANITARY FITTINGS, VALVES, PUMPS, TUBING, SPECIALTIES

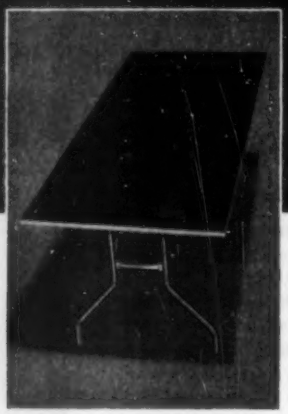
TRI-CLOVER

THE Complete LINE

FABRICATED STAINLESS STEEL INDUSTRIAL FITTINGS AND INDUSTRIAL PUMPS

PRODUCTION INCREASED 33%





SOUTHCO DRIVE RIVETS

eliminate surface holes...
improve appearance...speed production

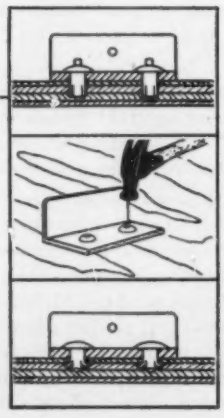
A Philadelphia manufacturer of food display equipment and banquet tables fastens folding aluminum legs to ¾" plywood table tops. SOUTHCO Drive Rivets are used to fasten leg assemblies to table tops because they are fast, strong and don't mar the table top.

Previously nuts and bolts were used but these required countersunk surface holes which, even though filled and sanded smooth, still marred the surface. Wood screws were tried but they pulled out. Four assemblies are now made in time formerly required for three.

In addition, the sales manager says "SOUTHCO Rivets have increased sales value of tables immeasurably".

SOUTHCO Drive Rivets are ideal for metal-to-wood applications. Just place in a blind hole, hit the pin and the rivet's in. No special tools, no bucking, nothing to finish off, no waste of time or material. SOUTHCO automatic pull-up draws parts tightly together, makes a tough, strong joint—quickly.

How can you benefit from using SOUTHCO Drive Rivets? Write for complete details to Southco Div., South Chester Corp., 1406 Finance Building, Philadelphia 2, Pa.



Place rivets in blind holes

Hit the pin . . .

Rivets expand in wood, pull-up is perfect

SOUTHCO
FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

Design Your Own Precision Gaging Fixtures

. . . around this Inexpensive Gage Head Cartridge

Measures by .0001" —.00001"

Compact, shock-proof, and moisture-proof, this Brown & Sharpe Gage Head Cartridge No. 953 gives you a simple means for designing high precision into your own gaging fixtures.

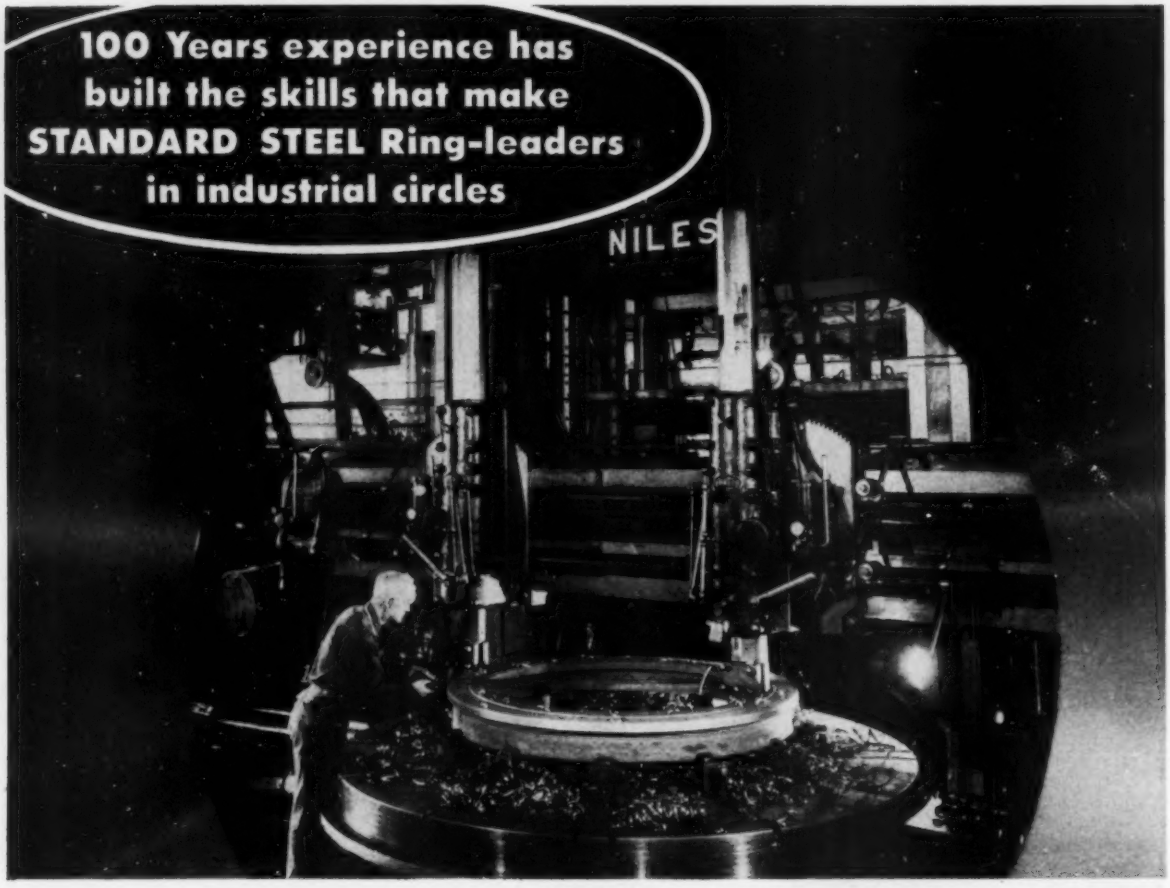
Readings in .0001" to .00001" are taken on the No. 950 Electronic Amplifier. Simply plug the cartridge into the amplifier. You take readings directly from the amplifier's accurately graduated dial . . . only one master required for setting. And you can design cartridges into several fixtures and use the same amplifier on all of them.

The unique design of the cartridge provides simple adjustment, frictionless movement, adjustable measuring pressure, and wide adaptability to many inspection devices, jigs, fixtures, and machines. Write for detailed Bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

BUY THROUGH YOUR LOCAL DISTRIBUTOR

Brown & Sharpe BS

100 Years experience has built the skills that make STANDARD STEEL Ring-leaders in industrial circles



Photographed through one of the smallest forged rings made by Standard Steel, this 120-inch Niles vertical boring mill is machining a gun base mount stand ring which will have a finish O.D. of 69½ inches, which operator is checking.

Experience builds skill, and skilled manufacturing produces quality products. Standard Steel Works has had 100 years of experience to build the manufacturing skills that produce finest quality weldless rings and flanges.

Standard Steel's experience has developed to a high degree the skills that make possible accurate quality control of the analysis and physical properties of their steels . . . close control of heat treatment, rolling and other forming operations . . . precise machining to assure finishing of rings and flanges to exact specifications.

You can't ignore experience as a guide to quality, and Standard Steel's experience is hard to match . . . still another reason why you can always rely on Standard Steel for rings and flanges.

ONE OF SIX REASONS why you should call Standard Steel for forgings and castings.

1. Experience—produced by skilled workmen with 20 to 40 years experience.
2. Quality Steel—through production of own steel by acid process.
3. Uniformity—assured by precise control of forging and rolling operations.
4. Fast Service—a vital factor in the continuing growth of Standard Steel for over 150 years.
5. Testing—radiographic tests, tensile tests, hardness tests, ultrasonic probing of internal structure, etc.
6. Capacity—unsurpassed ability to produce forgings and castings of unusual sizes and shapes, such as weldless rings all the way up to 144" O.D.

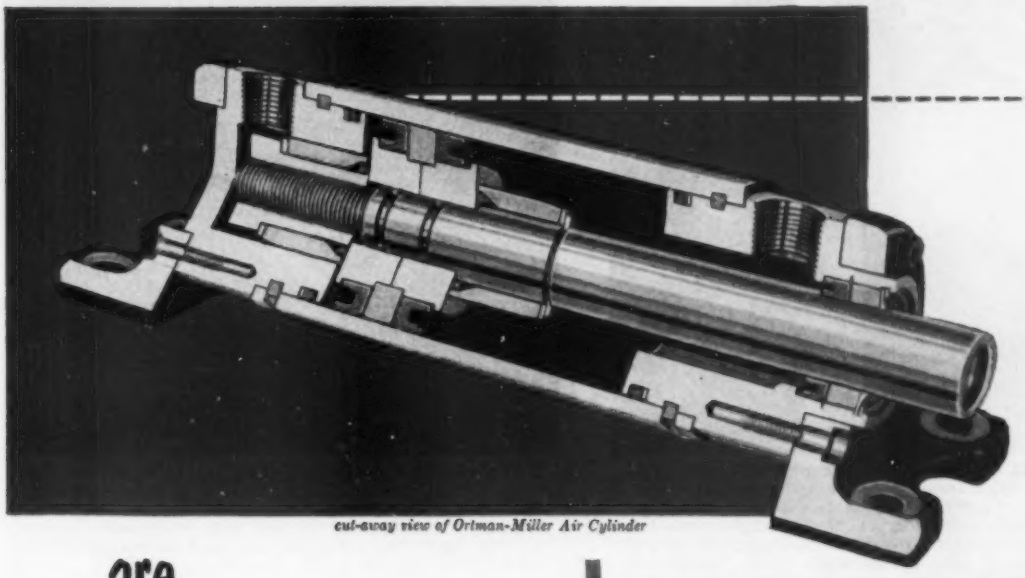
For more information, write Dept. 8535

Standard Steel Works Division
BURNHAM, PENNSYLVANIA

BALDWIN BLH LIMA-HAMILTON

BALDWIN-LIMA-HAMILTON
General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

O-M AIR • HYDRAULIC CYLINDERS



cut-away view of Ortman-Miller Air Cylinder

are easier to install • easier to service on any application!

FITS— where others won't

14 day delivery on most sizes

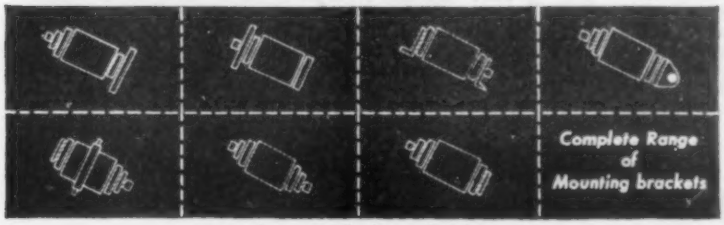
The compact, space-saving design, free from projecting tie rods and end caps, makes O-M Cylinders easy to slip in and out of the deepest recesses in machine bases and other hard-to-reach locations. For installation in unusually close quarters, O-M All-Steel Cylinders (with Bearing Bronze—NO Castings) can be turned down to fit.

The internal-locking key, that eliminates the need for tie rods and end caps, makes it possible to quickly and easily disassemble any O-M Cylinder, for inspection or service, without wrenches. There are no gaskets to replace when cylinders are reassembled.

O-M Cylinders "Fit Where Others Won't." They have the lowest coefficient of friction of any cylinder, thus, are smoother operating at low or high speeds. All end plugs are tapped for universal mounting.

Available in a complete range of sizes (1½" to 8" bores), with standard, 2 to 1 oversize drive rods. Completely interchangeable parts.

Write TODAY for FREE Catalog and free set of ½ and ¼-scale templates showing all cylinders and mounting brackets.



interchangeable bore for bore

ORTMAN-MILLER MACHINE CO.
1218 150th Street, Hammond, Indiana

☐ Please send latest O-M Catalog
☐ Please send Complete Set of Templates

Name..... Position.....
Company.....
Address.....
City..... Zone.... State.....

How would YOU solve these 2 problems?

1. IN SOFTBALL MANUFACTURE the most troublesome problem was to obtain absolute uniformity in the kapok cores. These determined hardness, density and shape of the finished balls. H. Harwood & Sons, Inc., of Natick, Mass. solved this problem by molding the cores under hydraulic pressure at closely controlled high temperature. Two inexpensive THERMOSWITCH units per mold provide the needed temperature control at low cost.

2. TAKING THE STRETCH and shrink out of Nylon fish line posed a big problem. It can only be done under high heat. One manufacturer was quoted $18,000 for complicated control equipment. Instead — and very successfully — he stretches the line in a heated die, temperature-controlled by a Fenwal THERMOSWITCH. Cost, less than $25!

3. THIS IS IT — the Fenwal THERMOSWITCH control is simple — compact shell contracts or expands *instantly* with temperature changes, opening or closing electrical contacts. Adjustable and highly resistant to shock and vibration. Fenwal THERMOSWITCH units are solving temperature control problems and improving production throughout all industry.

4. SEND FOR THIS NEW CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write **Fenwal Incorporated, 28 Pleasant Street, Ashland, Massachusetts.**

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE . . . but only to heat

eliminate

SECONDARY BROACHING SURFACE—(Where the application demands an extra long bushing, this second step is added.)
PRIMARY BROACHING SURFACE—Stepped down O.D.
PILOT—smooth lead of slightly smaller O.D.
THIN WALL CONSTRUCTION—reduces weight, permits closer spacing.
CHIP RETAINER GROOVES—sized to handle all excess displaced metal.
Aeroquip Bushings are made of HARDENED STEEL and treated with BLACK OXIDE PENETRATE to prevent rust and corrosion.

with new AEROQUIP BUSHINGS

"the bushing with the broach"

Aeroquip knocks the "H" out of H.C.B. (High Cost Boring) with inexpensive Broach-Fit Bushings. Accurate results are assured with low cost reaming of tolerances up to .002". Even unskilled personnel can install them, thanks to these unique features: A SERRATED OUTER SURFACE that forms dozens of knife-like edges and permits the bushing to actually *cut* its way into plastics, cast metal, or other metal parts without danger of collapse or cracking. A PILOT that squares the bushing with the hole to prevent cocking. CHIP RETAINER GROOVES that gather displaced metal and help lock the bushing firmly into position. Aeroquip Broach-Fit Bushings cost so little that you can use them in many places where conventional types prove too expensive. A wide range of sizes is available, please write for complete information.

REG. TRADE MARK

Aeroquip

AEROQUIP CORPORATION, JACKSON, MICHIGAN

SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA. • MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

CONTROL FLUID FLOW WITH MICROMETER ACCURACY

with

HANNA *Flo-Set* VALVES

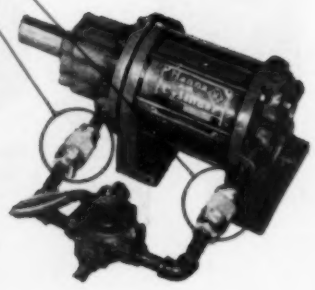
- CONTROLS FLOW OF AIR, OIL OR WATER
- ACCURATELY PREDETERMINES RATE OF FLOW
- RANGE FROM CLOSED TO FULL PIPE LINE CAPACITY
- LOCKS AT DESIRED SETTING
- HAS CONTROLLED FLOW OUT—FREE FLOW IN
- NON-CORROSIVE LIGHT WEIGHT ALUMINUM BODY
- EASILY ADJUSTABLE IN ANY MOUNTING POSITION

With Hanna Flo-Set Valves you can predetermine the exact rate of flow of gases and liquids. A micrometer scale, representing 1/100 of the pipe area for each graduation, enables you to set exactly the rate of flow desired. A simple locking device guards against tampering or accidental change of adjustment.

Since all Hanna Flo-Sets have full pipe line capacity, they may be used in place of larger conventional valves. Installation of pairs of Flo-Sets in your air and hydraulic circuits provide independent adjustment of forward and return piston speeds.

Hanna Flo-Set valves are available in three sizes: ½", ⅜" and ¼".

Write today for the new illustrated Hanna Valve Bulletin No. 257.



Hanna Engineering Works

1763 ELSTON AVE. • CHICAGO 22, ILL.

HYDRAULIC AND PNEUMATIC EQUIPMENT...CYLINDERS...VALVES...RIVETERS

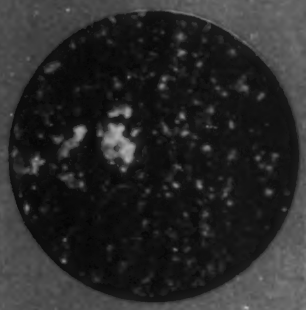
NEW PHOTOMICROGRAPHS SAY IT BETTER THAN WORDS

this is why

HOUGHTON VIX-SYN PACKINGS

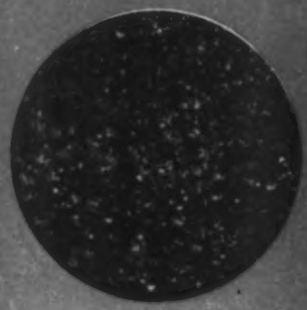
give you better service

Cross-section of average compound



Coarser, less dense pattern of rubber is indicated in this photomicrograph of a standard packing compound, magnified 240 diameters. Visual evidence that pliability and wearing qualities are only fair.

Cross-section of Vix-Syn compound



Fine-grain density of rubber throughout Houghton Vix-Syn Packing is shown in this cross-section similarly magnified. This compact, homogeneous quality means superior flexibility and assures long, hard service.

As you've seen in the magnified photos above, our special molding process produces a full fine-grained texture of synthetic rubber *throughout the packing.*

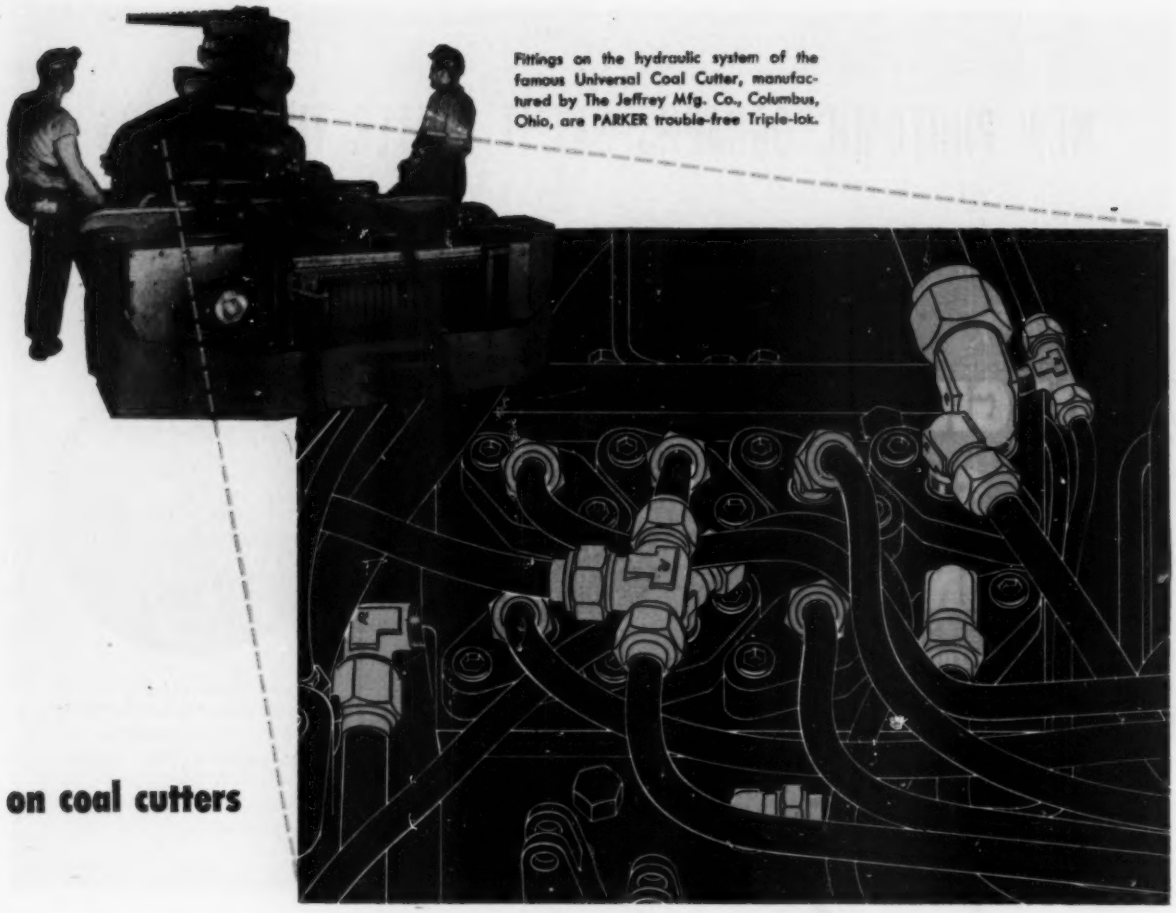
This homogeneous compound of synthetic rubber promises you a number of outstanding advantages. Its exceptional pliability, for example, makes installation easy and a tighter seal possible in all hydraulic applications. Its resistance to heat, oils and solvents prolongs the life of the packing. Efficient operation is assured under a wide range of pressures up to 15,000 psi.

Houghton Vix-Syn Synthetic Rubber Packings are available in "V's", "U"-cups, gaskets and "O" rings. Vim leather back-up washers specifically designed for use with "O" rings, and fabricated rubber packings, are also supplied. Ask your Houghton Man for latest bulletin, or write to E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

VIM and VIX-SYN PACKINGS
. . . products of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .



Fittings on the hydraulic system of the famous Universal Coal Cutter, manufactured by The Jeffrey Mfg. Co., Columbus, Ohio, are PARKER trouble-free Triple-lok.

on coal cutters

Tube it up...Forget it...WITH PARKER

TROUBLE-FREE TRIPLE-LOK FITTINGS

Few machines get rougher use than coal cutters in coal mines. Subjected to severe vibration, caused by the action of the cutting head, and operating under the most adverse conditions, all parts must be ruggedly built, including the hydraulic system.

You'll find Parker Triple-lok Fittings on coal cutters and many other machines used in rough, rugged service because they are leakproof under the severest conditions of vibration, elevated temperatures, high pressures and repeated assembly. Parker Fittings meet the specifications of the A.S.M.E. Code for Pressure Piping, as well as J.I.C. and S.A.E. standards.

So *tube it up* and *forget it* . . . with Parker Triple-lok Fittings. Ask your Parker Distributor for Tube Fitting Catalog 4300, or write The PARKER Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio.

This does it

Triple-lok . . . 3-piece flare fitting famous for its sleeve . . . the easiest way to install tubing systems. Made in brass, steel, stainless steel, aluminum alloy.

Precision Mark of Leakproof Tube Fittings

Parker

TUBE FITTINGS • VALVES • O-RINGS

Plants in Cleveland • Los Angeles • Eaton, Ohio • Berea, Ky.

Parker

INDUSTRIAL TUBE FITTING

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BALTIMORE 5, Md.—Whitehead Metal Products Co. 4300 E. Monument St.
BEAUMONT, Tex.—Standard Brass & Mfg. Co., 705 Milam St.
BOSTON 15, Mass.—A. E. Borden Co., 176 Brookline Ave.
BRYSON CITY, N. C.—Wallace Co. of Carolina, P.O. Box 572
BUFFALO 7, N. Y.—Whitehead Metal Products Co. 2128 Elmwood Ave.
CAMBRIDGE 39, Mass.—Whitehead Metal Products Co. 281 Albany St.
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CHICAGO 14, Ill.—Wallace Tube Co., 1300 Diversey Pkwy.
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NEW YORK 12, N. Y.—Nielsen Hydraulic Equipment, Inc. 298 Lafayette St.
NEW YORK 14, N. Y.—Whitehead Metal Products Co. 303 West 10th St.
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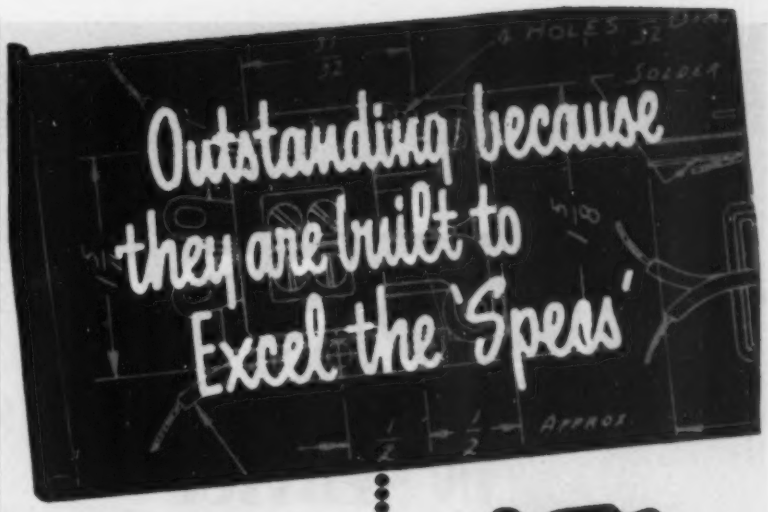
SAN FRANCISCO 3, Cal.—General Machinery & Sup. Co. 1346 Folsom St.
SEATTLE 9, Wash.—Palmer Supply Co., 222 Westlake, N.
SHREVEPORT, La.—Standard Brass & Mfg. Co. 1557 Texas Ave.
ST. LOUIS 15, Mo.—Metal Goods Corp., 5239 Brown Ave.
SYRACUSE 4, N. Y.—Whitehead Metal Products Co. 207 W. Taylor St.
TOLEDO 2, O.—Williams & Co., 650 E. Woodruff Ave.
TULSA, Okla.—Ardun Supply Co., 317 S. Detroit
TULSA 3, Okla.—Metal Goods Corp., 302 North Boston
CANADA—Railway & Power Engineering Corp. Ltd.
EXPORT—Mercator Corp., 438 Walnut St., Reading, Pa.



R 45 SERIES—Small telephone type relay with pin hinge construction. Available with multiple contact springs up to six pole double-throw. Capacities: 1 amp., 3 amp., or 5 amp. Normally supplied for D.C. operation. Hermetically sealed or open. 1-13/32x1-1/4x1-7/32 to 1-5/8 high.

R 83 SERIES—Available with A.C. or D.C. coils. Contact ratings up to 30 amperes continuous, 150 amperes inrush with single pole double-break arrangement. Multiple contact springs with proportionately lower ratings also available. Size: 1-7/8x1-5/16x1-5/8 high.

R 94 SERIES—Hermetically sealed small telephone type relay with pin hinge construction for long life. Available in D.C. only with contact springs up to 4 pole double-throw. In 1 amp., 3 amp., or 5 amp. capacity. Plug-in or solder terminals. Overall size 1-5/8 x 1-1/32 x 2-1/4 D.

RB 45 SERIES—Similar to R 45 with the exception that it is designed to fit the hermetically sealed enclosure shown. Three stud mounting; solder terminals. Available up to 4 pole double-throw. Widely used in aircraft and ground communication equipment. Size: 1-5/8 x 1-7/16x2-1/32 D.

"Diamond Quality" TIME SWITCHES...

Automatic Electric also produces a complete line of Time Switches and Timers, both manual and automatic reset. Write for information.

AEMCO

Automatic Electric MFG. CO.

66 STATE STREET MANKATO, MINN.

ELECTRICAL
CORDS
KEEP YOUR APPLIANCES
IN SERVICE
MANUFACTURERS WHOSE PRODUCTS SERVE BEST...
Specify Belden
WIREMAKER FOR INDUSTRY

"WHY DON'T YOU TRY AETNA? YOU'LL BE SURPRISED AT THEIR VERSATILITY"

Yes, Aetna *is* versatile. For 37 years Aetna has been making original equipment bearings and precision parts for the nation's leading manufacturers in the automotive, farm implement and general industrial fields.

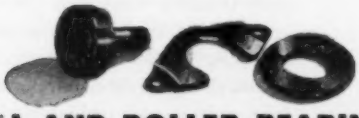
From conventional light duty thrust bearings in 1916, Aetna's versatility has grown to include all-type-all-duty ball thrust bearings, roller bearings and vital parts spanning an incredible range of industrial applications.

It's worth remembering—Aetna's diversified usefulness to industry—Aetna's reputation of producing to the stiffest tolerances known to the industry.

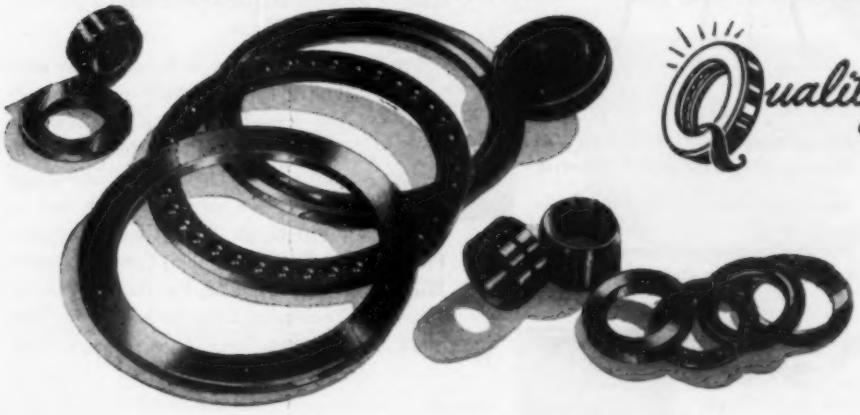
If you are having bearing or parts troubles—if you need a more versatile, more dependable supplier, consider Aetna. Your satisfaction is assured by the fact that 80% of our business comes from firms we have served for 20 or more of our 37 years. Write! Just state your problem, send your prints, or ask that a near-by representative drop in. No obligation. Aetna Ball and Roller Bearing Company, 4600 Schubert Avenue, Chicago 39, Illinois.

In Detroit — Sam T. Keller — 2457 Woodward Avenue

Aetna



BALL AND ROLLER BEARINGS • MISCELLANEOUS PRECISION PARTS



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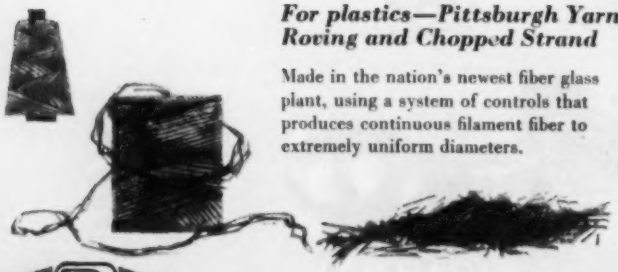
FIBER PG GLASS

Helps make plastics *better...* *safer... lighter...* *stronger*

Fiber glass is one of the big reasons why the use of plastics continues to expand so rapidily. With fiber glass reinforcements, plastic laminates attain the greatest strength per weight ratios of all materials. And they are being made to utilize numerous other properties, too —resistance to high temperatures, to water and oils, to electrical stresses, to corrosive chemicals and vapors. Important design, production and cost advantages are thus being realized in the manufacture of many structural and electrical products.

Pittsburgh Fiber Glass is being widely used in this field, especially where exceptionally uniform fiber diameters are an advantage in producing laminates to close tolerances. Our technical staff will be glad to lend assistance with any application involving the use of fiber glass. Pittsburgh Plate Glass Company, Fiber Glass Division, 420 Fort Duquesne Boulevard, Pittsburgh 22, Pa. District Offices: Chicago, Cincinnati, Cleveland, Detroit, New York, Washington.



For plastics—Pittsburgh Yarns, Roving and Chopped Strand

Made in the nation's newest fiber glass plant, using a system of controls that produces continuous filament fiber to extremely uniform diameters.

FIBER PG GLASS **PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS**

PITTSBURGH PLATE GLASS COMPANY

Where weight and space are critical

New miniature transducers expand the scope of dynamic recording systems

A BASIC PROBLEM in transducer design is reduction of size to a point where characteristics of the device under test are not affected. Two new transducers developed by Consolidated combine unusually small size and weight with operating characteristics fully comparable to previous larger instruments.

The 4-310 Pressure Pickup features a direct-sensing diaphragm and is mountable flush with any surface to avoid both volume changes in the pressure chamber and spurious turbulence patterns. It is valuable for aerodynamic pressure surveys and other high-frequency liquid or gaseous pressure measurements.

The new 4-118 Velocity Pickup is usable at high temperatures in any plane of orientation. Its output equals instruments many times its size and weight, yet it has no loading effect on structures being tested. Applications include turbine, supercharger, rocket and jet engine vibration studies.

4-310 pressure pickup

Sensitivity: 4 mv/v of applied excitation.

Ranges: 5, 15, 50, 150 psi.

Temperature range: —100°F to +250°F.

Sensitive element: 350-ohm, 4-arm resistance bridge.

Excitation: ac or dc.

Linearity and hysteresis: excellent characteristics.

Acceleration response, zero and sensitivity drift: negligible.

Versatility: usable for liquid or gas measurements.

Size: diaphragm diameter ½", length 5/8".

Complete specifications in Bulletin 1534A-X3.

4-118 velocity pickup

Output: 100 mv/in./sec. @ 250 cps.

Frequency range: linear ±10% from 50 to 500 cps over range of —65°F to +500°F.

Amplitude limits: to 0.12" peak-to-peak.

Transverse sensitivity: negligible.

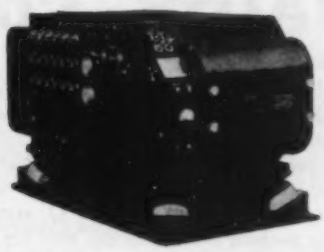
Sensitive element: self-generating, nominal 700-ohm dc coil resistance.

Total weight: 1.3 ounces.

Size: ¾" diameter, height 1".

Complete description and specifications in Bulletin 1535-X3.

Vibration can be easily, precisely measured and monitored by combining the Velocity Pickup with Consolidated's Vibration Meters, described in Bulletin 1505B.



Transient or high-frequency vibrations and pressure changes can be recorded for detailed study with Consolidated's Recording Oscillographs. Send for Bulletin 1500B.

Consolidated Engineering

CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

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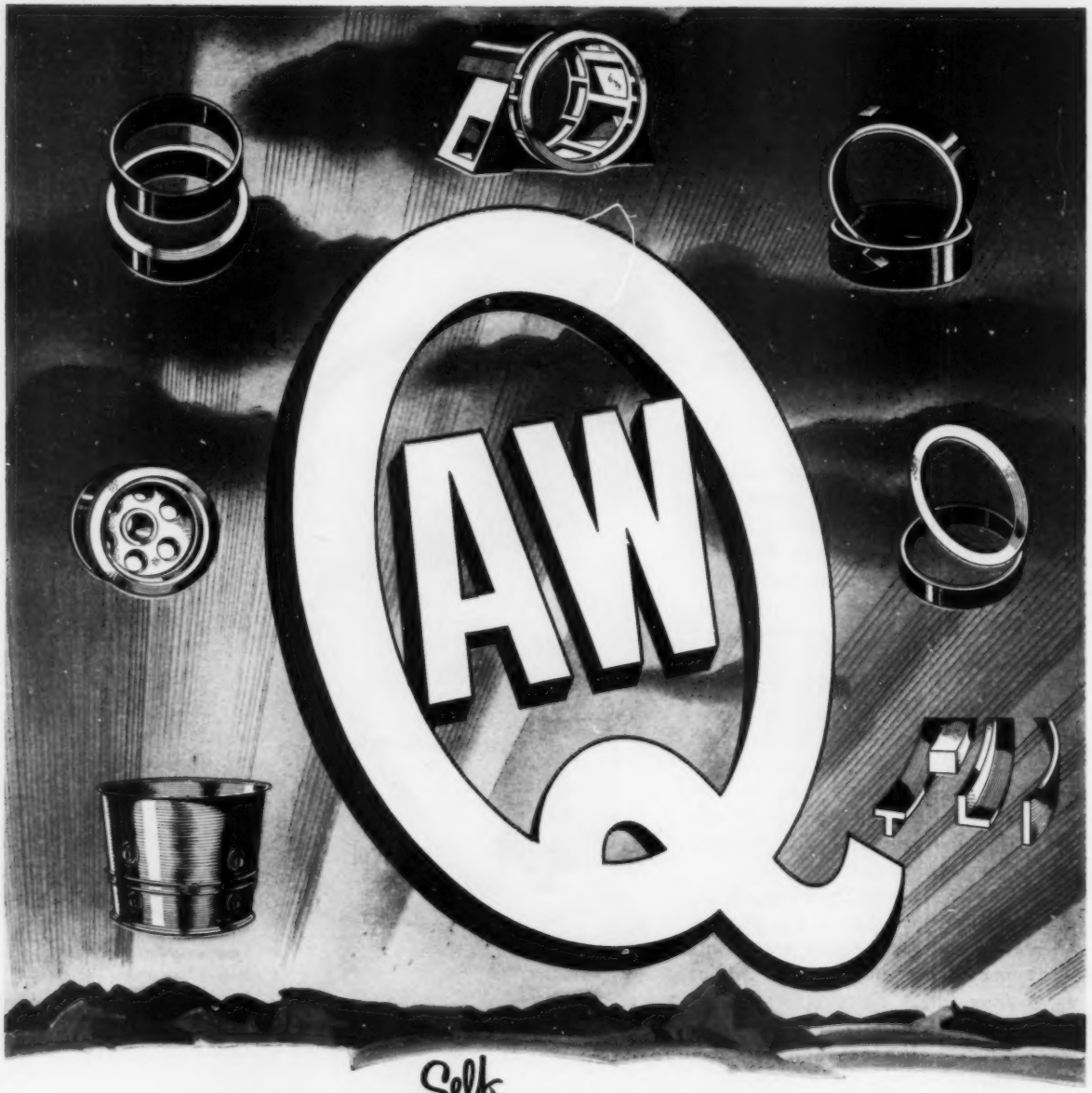
Miniature transducers

Consolidated's new miniature transducers, among the smallest ever designed for pressure and vibration measurement, are adaptable to the most exacting mounting requirements.



Self QUALITY CONTROL

Quality control is a term that can mean everything or nothing. At AMERICAN WELDING it is referred to as *quality self control.*

Every man and woman at AMERICAN WELDING feels an individual responsibility to make his work conform to the standards represented in the A.W.Q. symbol.

It's the *personal* symbol of the 800 experts that are joined in a common pledge to give you the best in welding.

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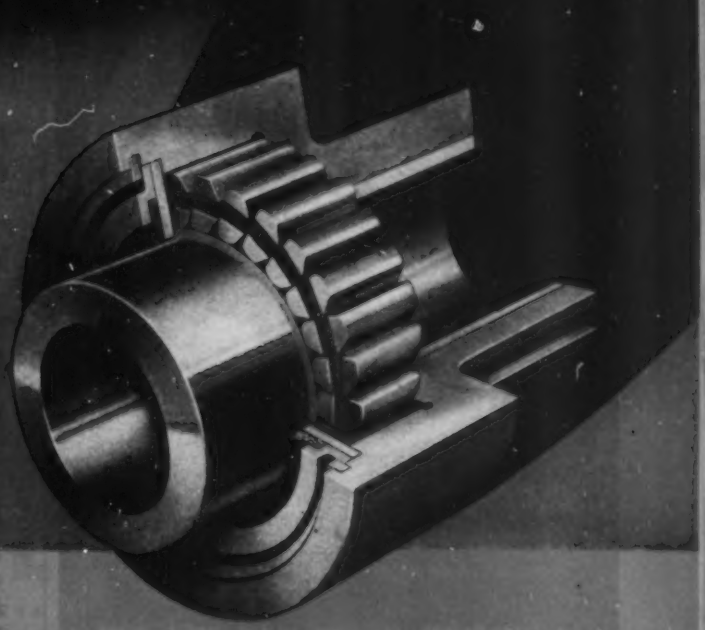
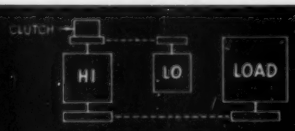
FORMSPRAG Clutches

FULL COMPLEMENT



OVER-RUNNING



Typical Arrangement:

Drive is transmitted through clutch during low speed cycle. Clutch over-runs during high speed cycle.

INDEXING

Typical Arrangement:

Continuous rotary motion of crank A produces oscillation of arm B. Attached to outer race (or in some cases, the inner race) of clutch, arm B produces intermittent forward rotation of shaft C.

BACKSTOPPING

Typical Arrangement:

One race of clutch is attached to stationary member and other race is attached to rotating part of mechanism. Clutch permits rotation in one direction, but not in reverse.

Your inquiries about Roll-o-matic and Capsleeve Over-Running Clutches are welcomed by the Formsprag Company.

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Formsprag Clutches are ALL Full Complement Clutches

Their energized sprags grip at an infinite number of positions, giving instantaneous operation—no backlash—and long life because of low unit stresses . . . Before you specify another clutch be sure to read this folder.

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23607 Hoover Rd., Van Dyke, Mich.

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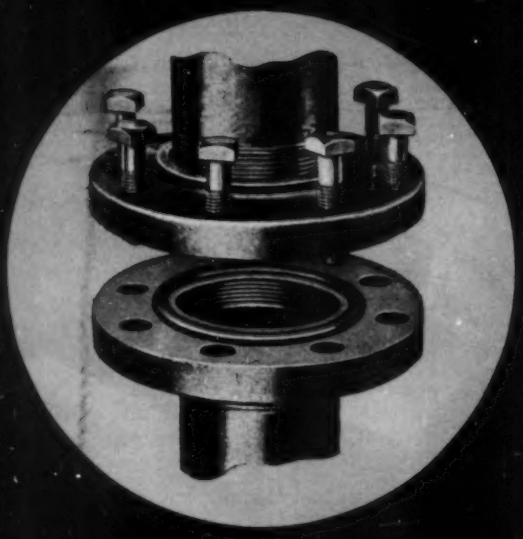
E-9

NOW—
a foolproof flange joint that seals tighter...LONGER



Through the use of Linear O-Rings, you can now design flange joints in pressure piping that completely eliminate all limitations of flat gasketing.

- **Easier assembly**: just draw up the joint to make metal-to-metal contact; no guesswork, no squeezing gaskets. You can design the bolted joint to stand only pressure loads, without adding a safety factor to compensate for gasketing.
- **Leakproof seal**: Linear O-Rings seal perfectly at any pressure . . . never loosen from vibration.
- **Zero maintenance**: no need for periodic re-tightening to compensate for compression set; no danger of damage from over-tightening.

Precision-moulded Linear O-Rings are supplied in silicone and many other natural and synthetic rubbers. Write or call Linear for full data.

"PERFECTLY ENGINEERED PACKINGS"

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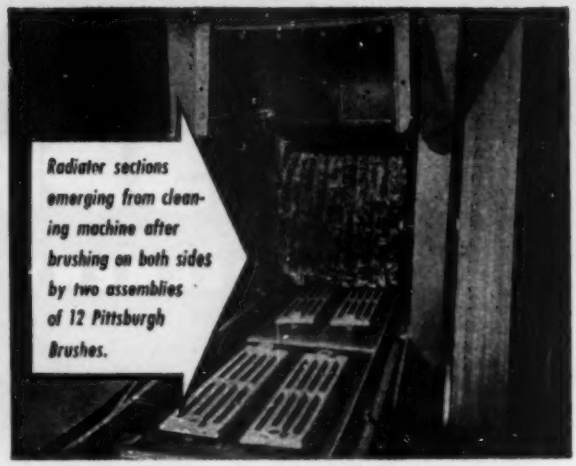
LINEAR, Inc., State Rd. & Levick St., Philadelphia 35, Pa.



Radiator sections emerging from cleaning machine after brushing on both sides by two assemblies of 12 Pittsburgh Brushes.

Pittsburgh Brushes can help you solve problems like these!

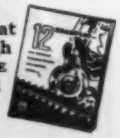
Cleaning Narrow Spaces—National Radiator Company, Johnstown, Pa., cleans 30,000 radiator sections a week! To insure a perfect final finish, even the narrowest spaces must be absolutely clean prior to assembly. Pittsburgh engineers were asked to design a brush that would reach these spaces and would fit National's existing machine. Successful? National reports: "Pittsburgh Brushes do a better job of cleaning and are more economical!"

Preparing Chills—At Continental Foundry & Machine Co., East Chicago, Indiana, chills used to cast iron rolls must be cleaned of the oxidized metal remaining from previous usage, as well as dirt and grease accumulated in storage. After experimenting with other brushes, Continental chose Pittsburgh because they "do the job better and stand up longer than any previously used!"

Improving Original Equipment—The Sommer and Maca Glass Machinery Co., Chicago, Illinois, uses Pittsburgh Brushes in the automatic washing machines they manufacture. Brushes formerly used simply didn't have the over-all density pattern needed. Pittsburgh engineers studied the problem and designed a brush which Sommer and Maca approved "because of (its) denser bristle pattern and lower cost."

WRITE TODAY FOR FREE BOOKLET!

Write today for a free copy of our booklet that shows, through actual case histories, how Pittsburgh cuts brushing costs. Address: PITTSBURGH PLATE GLASS COMPANY, *Brush Div.*, Dept. W-6, 3221 Frederick Ave., Baltimore 29, Maryland.



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BRUSHES

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more sizes of...
Stainless Socket Cap and Set Screws
Available in stock from your Allen o Distributor

Demand for rust and corrosion resistant socket screws of high finish 18-8 stainless steel has been increasing steadily for ten years.

Allens have become the leading make because of the inherent advantages of Allen manufacturing methods, and because Allen Distributors carry the widest range of sizes as standard stock items – saving their customers time and money.

Now Allen widens its margin of leadership with still more distributor-stocked standard sizes in stainless:

97 Standard Sizes in Stainless Steel Socket Cap Screws

#4 x ¼" to ⅜" x 3" with NC threads
#10 x ⅜" to ⅜" x 1½" with NF threads

54 Standard Sizes in Stainless Steel Socket Set Screws

#4 x ⅛" to ½" x 1" with NC threads
#10 in lengths from ⅜" to ¾" with NF threads

ALLEN
MANUFACTURING COMPANY
Hartford 2, Connecticut, U.S.A.

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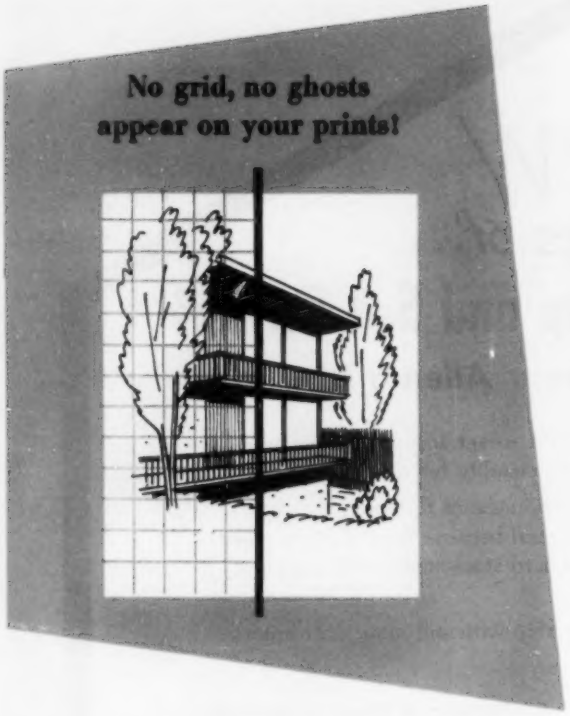

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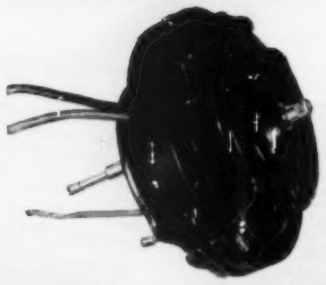
HEINZE MOTORS



New Capacitor Motor AM-100

Originally developed for TV antenna rotator service. Reversible. Excellent also for laboratory or experimental use: or for advertising displays, etc.

1/100 hp. 2-pole. Operates at free speed of 3300 rpm or load speed of 3100 rpm.

40 watts. 24 volts. 60 cycles. AC.

Skeleton frame, but can be supplied in ventilated case, same size and appearance as Heinze Type Z motor.

Mountings available.

The Heinze catalog shows this and other Heinze sub-fractional horsepower motors and blowers.

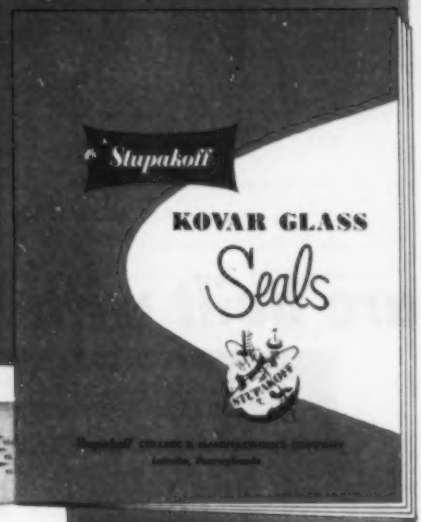
Heinze Electric Co

685 Lawrence Street, LOWELL, MASS

new catalog
now available!

UP-TO-DATE INFORMATION ON COMPLETE LINE OF STUPAKOFF SEALS

CONTAINS DIMENSIONS, RATINGS, AND OTHER USEFUL DATA



In addition to information on standard and special types of seals, this 32-page catalog has an engineering section with suggestions for manufacturers who wish to develop their own designs.

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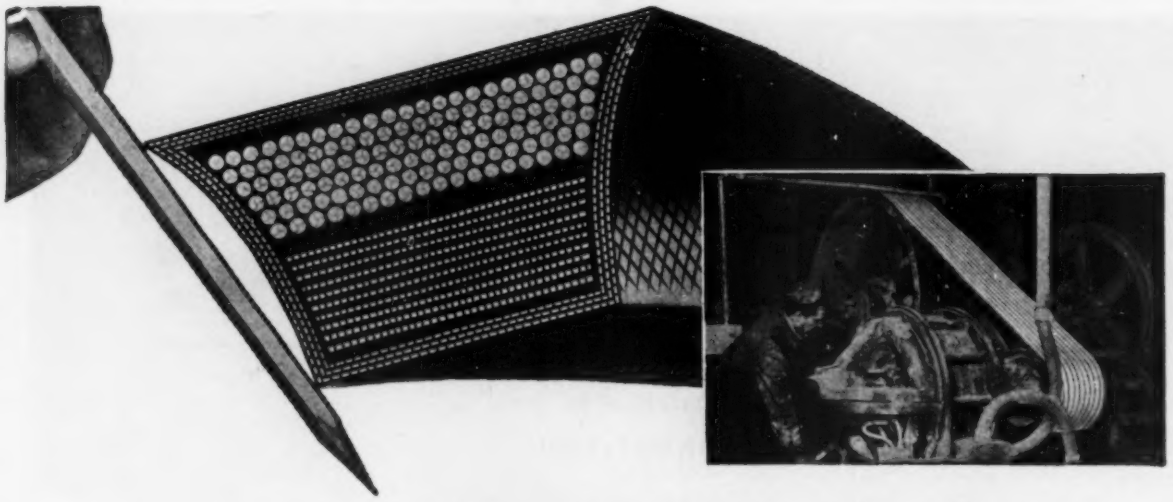


Gates V-Belts are built with CONCAVE SIDES

(U.S. PATENT NO. 1813698)

...that's why they last longer!

If you want lower V-Belt costs, just make this simple test...pick up *any* V-Belt and bend it as if it were going around a pulley.

As the belt bends, grip its sides between your fingers and thumb.

If the belt has *straight sides* you feel the sides bulge out. This forces the sides of the belt to press *unevenly* against the V-pulley . . . and you get concentrated wear at the points shown by the arrows.

Now, try this same test with the V-Belt that is built with CONCAVE SIDES **—the Gates Vulco Rope.**

As this belt bends, you can feel the CONCAVE SIDES *fill out* and become perfectly straight.

These sides press *evenly* against the V-pulley. All wear is distributed *uniformly* across the full width of the Gates Vulco Rope and the CONCAVE SIDES therefore mean longer belt life and lower V-Belt costs for you.

When you buy V-Belts, be sure to get the V-Belt with the CONCAVE SIDES—the Gates Vulco Rope!

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and in 71 foreign countries.

CS-938

V-Belts — Hose
Molded Rubber Goods
for Industry
World's Largest Maker
of V-Belts

Gates® VULCO ROPE DRIVES

THE GATES RUBBER COMPANY • DENVER, U.S.A.

Only SEALMASTER Gives You Positive Locking Plus Easy Shaft Mounting

SEALMASTER BEARINGS now provide the first practical answer to positive shaft locking with easy shaft mounting. Just slip the bearing onto the shaft . . . tighten two set screws . . . that's all. This is made possible through ZONE HARDENING.*

SEALMASTER BALL BEARING UNITS

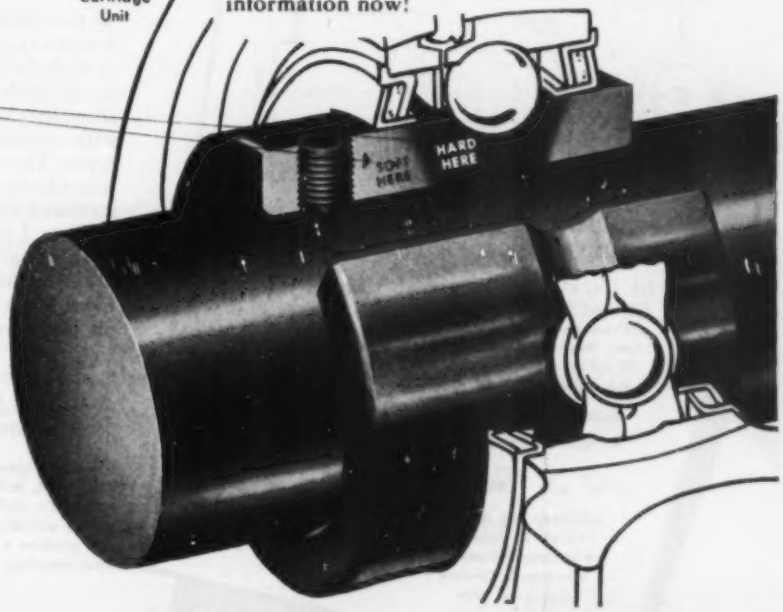
Cartridge Unit | Flange Unit | Take-Up Unit | Flange-Cartridge Unit

With Zone Hardening, the inner race of the bearing is hardened through the ball path section only. The rest of the race is left in its original, metallurgically soft state. The threads of the hardened set-screws bind firmly in this softer portion of the race and cannot work loose. This insures positive race-to-shaft locking for the life of the bearing.

In the machines you design, build or use, SEALMASTER Zone Hardening means better bearing performance, less maintenance and replacement costs. Write for full information now!

***ZONE HARDENING**

.s a completely automatic heat treating process with timing controlled *to the tenth of a second.* In addition to enabling positive race-to-shaft locking, it provides a finer grained, metallurgical structure of uniform hardness in the ball path section. This gives better load carrying ability. Zone Hardening is patented . . . only SEALMASTERS have it.



SEALMASTER BEARINGS

A DIVISION OF STEPHENS-ADAMSON MFG. COMPANY
9 RIDGEWAY AVENUE, AURORA, ILLINOIS

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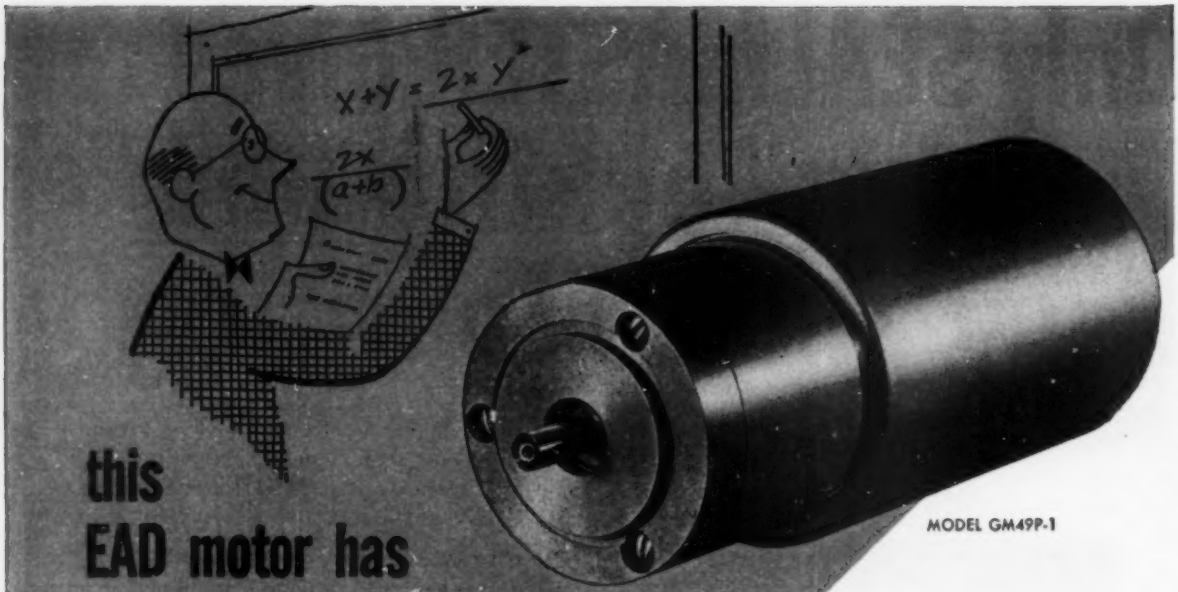
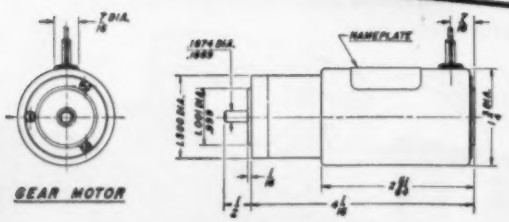


MODEL GM49P-1

this EAD motor has a "head" for torque problems



GEAR MOTOR

SPECIFICATIONS FOR MODEL GM49P-1

400 Cycle Capacitor Run Induction Gear Motor

115 Volts • 400 Cycles • 1 Phase • 0.5 Amps.
Full Load Torque: 100 Oz.-In.
Starting Torque: Over 100 Oz.-In.
Gear Head Lubricated per Mil-G-3278
22 R.P.M. • 314 to 1 Gear Ratio • Reversible Rotation
Intermittent Duty: 15 Minutes on, 15 Minutes off

Ambient Temperature: −55° to +74° C
Altitude: to 50,000 Ft.

TYPICAL APPLICATIONS

- Military and Aircraft
- Follow Up Devices
- Instrument Controls
- Automatic Controls
- Automatic Pilot
- Radar Equipment
- Electronic Control
- Actuators
- Timers

A precision gear head combined with a miniature motor gives you the answer to high torque at low speed. The motor can be 60 cycle, 400 cycle or variable frequency—in single, two or three phase—with non-cooled or self-cooled frame types. The gear head is arranged to provide the output speed you require, with standard timing ratios of 60, 3600 or 8000 to 1 possible. High output torques, to drive, actuate or control, in confined areas, make this line of tiny gear motors ideal for a wide variety of applications on the ground and in the air.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

If your problem involves rotating electrical equipment, bring it to EAD. Our completely staffed organization will modify one of our standard units or design and produce a special unit to meet your most exacting requirements.

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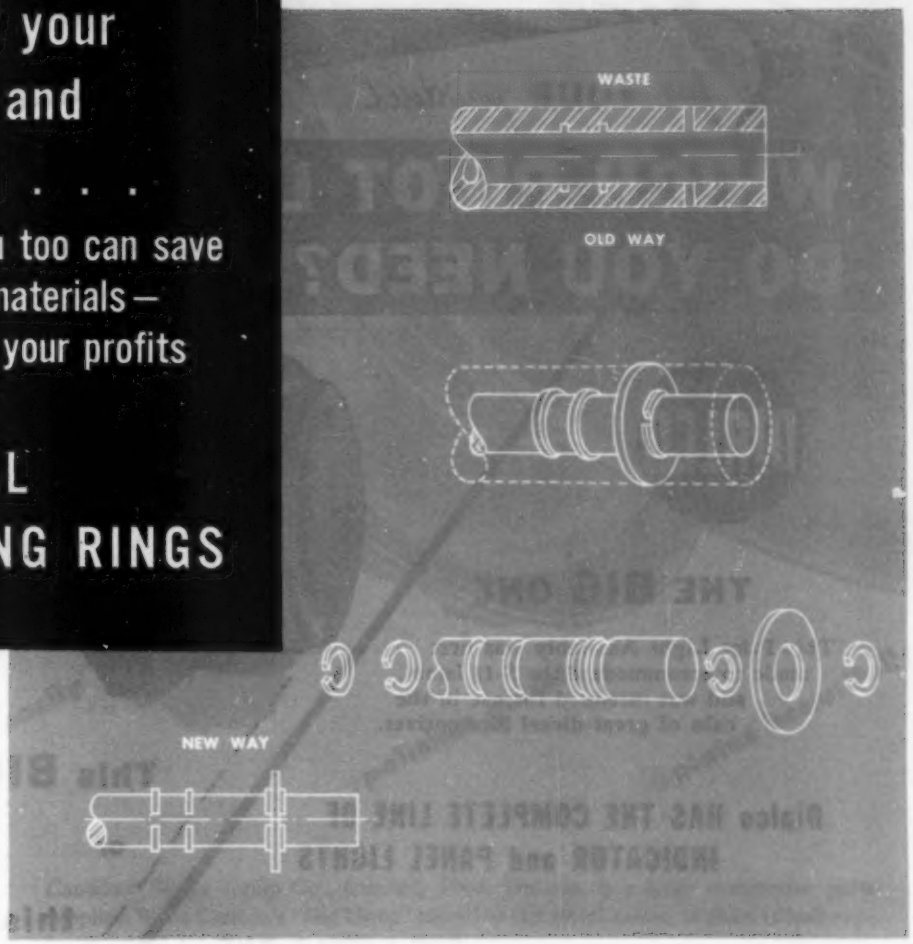
No doubt you too can save time—save materials—and increase your profits by using

NATIONAL RETAINING RINGS



There are literally thousands of places where retaining rings will *save*, ranging from simple applications on tools, toys, small parts and gadgets to complicated heavy duty engines, large drill presses, etc., etc.

And in addition to this economy, they *improve* your products. It is wasteful to cut down shafts to make shoulders. Redesign to groove *smaller* shafts and housings and use these high-grade steel rings.

Let our engineers consult with you. Send today for folders.

Don't pass up this opportunity to increase profits.

THE NATIONAL LOCK WASHER CO.

NEWARK 5, NEW JERSEY • MILWAUKEE 2, WISCONSIN, U. S. A.

for **YOUR** *product*

WHICH PILOT LIGHT DO YOU NEED?

DIALCO

Cat. #613529-211

THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

This BIG one

or

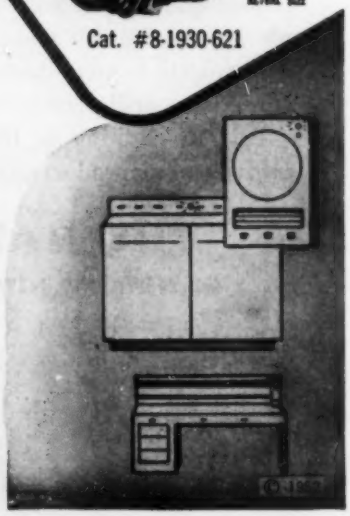
this LITTLE one

Dialco HAS THE COMPLETE LINE OF INDICATOR and PANEL LIGHTS

THE LITTLE ONE

The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.

Cat. #8-1930-621



Samples to suit your own special conditions and requirements will be sent promptly and *without cost.* Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.

Write for the Dialco HANDBOOK of PILOT LIGHTS

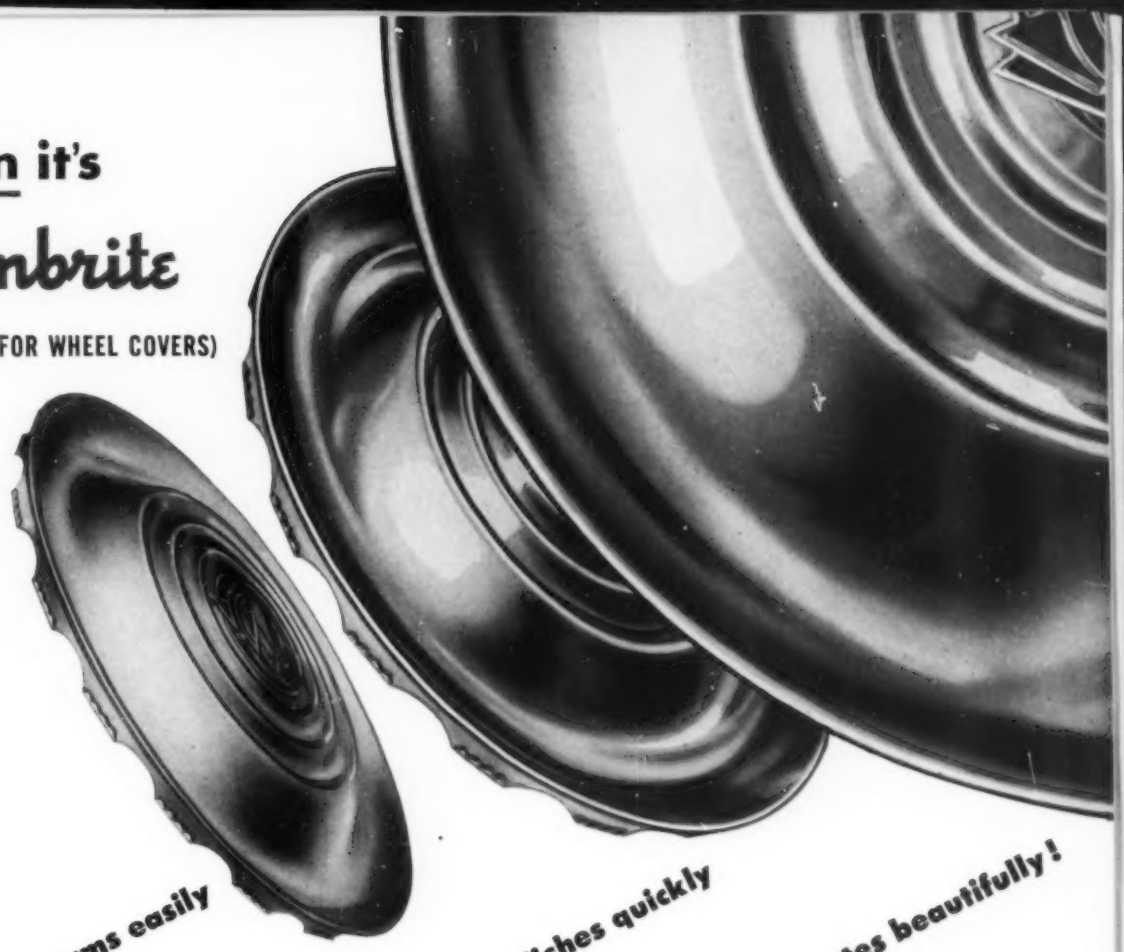
Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

60 STEWART AVE., BROOKLYN 37, N. Y. HYACINTH 7-7600

again it's Formbrite

(THIS TIME FOR WHEEL COVERS)



● it forms easily ● polishes quickly ● plates beautifully!

Canadian Motor Lamp Co., Limited, Ford, Ontario, is a large automotive parts supplier. When Canada's "Big Three" turned to full wheel covers in place of hub caps for many '53 models this supplier, suddenly facing a new set of production problems, turned to Formbrite*, exceptionally fine-grain Anaconda Brass. Here are the reasons:

1 Previous experience in manufacturing large quantities of chromium-plated brass hub caps made of Formbrite indicated that polishing operations could be reduced as much as 50%.

2 Formbrite had demonstrated its remarkable ductility for press operations—taking sharp, clean-cut, ornamental die impressions.

3 Formbrite was harder, stronger, springier and more scratch-resistant than ordinary drawing brass . . . desirable characteristics for the service involved.

4 Important, too, was the fact that Formbrite would provide the fatigue-resisting springiness to the gripping fingers that hold the cover to the wheel.

Now in full production on the new wheel covers, Canadian Motor Lamp's appraisals proved 100% correct. Maybe *you're* missing something by *not* using Formbrite. Write for Publication B-39, addressing The American Brass Company, General Offices, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.

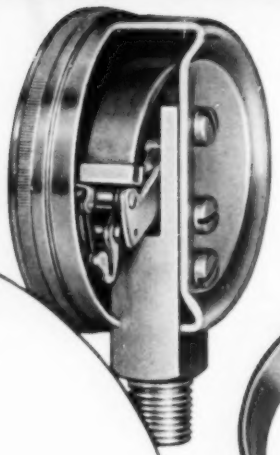
*Reg. U. S. Pat. Off.

Shown above is one of the 16 sets of gripping fingers which hold the 15" diameter wheel cover to the rim. The metal is yellow brass, .024" thick, supplied in coil as Formbrite.

Formbrite DRAWING BRASS

An **ANACONDA** product made by The American Brass Company

PRESSURE



It's big business at U.S. Gauge where **brass belongs**

At Sellersville, Pa., millions of pressure gauges are made each year—for every type of industry—to every degree of accuracy—and for pressures ranging from a few ounces per square inch up to 100,000 pounds.

With each gauge a precision instrument unto itself, it's quite a job to maintain the high standards of routine fabricating procedure on each of its many components. Part of it depends on having just the right copper alloy in the most satisfactory combination of chemical and physical properties. That's where teamwork between U. S. Gauge and Anaconda Metals has been clicking day after day, year after year.

and now—something NEW has been added . . .

U. S. Gauge is now using Formbrite* for many of its "polished and lacquered" and chromium plated solid brass gauge cases. Formbrite, with its superfine grain, provides a surface far superior to ordinary drawing brass. It is stronger, harder, more scratch-resistant than ordinary brass, yet retains remarkable ductility for forming and drawing. Best of all, Formbrite is a real time saver when it comes to finishing operations.

Want to know more about this "premium product at a non-premium price"? Write for Anaconda Publication B-39. Address: The American Brass Company, General Offices, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. *Reg. U. S. Pat. Off.

Formbrite DRAWING BRASS

An **ANACONDA** Product

Made by The American Brass Company

Gauge and components courtesy of

UNITED STATES GAUGE

DIVISION OF AMERICAN MACHINE AND METALS, INC.

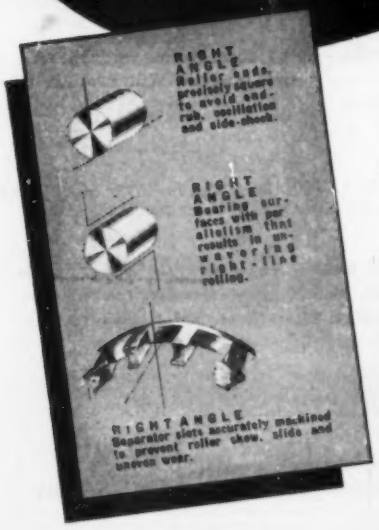
Sellersville, Pa.

For the ultimate in precision, eleven different Anaconda Alloys in the form of rod, tube, sheet and strip are used in producing the components of the U. S. Gauge illustrated above.

ROLLWAY Bronze-Retainer Roller Bearings

From 30" O.D. to 3" O.D.!

Regardless of size—regardless of type, radial or thrust—Rollway Roller Bearings roll right because they're made *right*. Net result of Rollway's precision "right angle design" is longer bearing service—under heavier loads—with lower maintenance cost.


RIGHT ANGLE Roller ends, precisely square to avoid end-rub, oscillation and side-thrash.
RIGHT ANGLE Bearing surfaces with parallelism that results in unwavering right-line rolling.
RIGHT ANGLE Separator slots accurately machined to prevent roller skew, slide and uneven wear.

• Our complete engineering and metallurgical services will gladly work with you on your problems. Simply write or wire any sales office. No cost. No obligation. Rollway Bearing Co., Inc., Syracuse 4, N. Y.

SALES OFFICES

Syracuse Cleveland Houston Boston Philadelphia Chicago
Pittsburgh Detroit Los Angeles Toronto Milwaukee

ROLLWAY BEARINGS

Complete Line of Radial and Thrust Cylindrical Roller Bearings

Gasket Materials to Tolerances of ± 5%

Asbestos-rubber gasket materials by Rogers Corporation feature superior thickness control plus homogeneity and dimensional stability.

UNIFORM AND PRECISE THICKNESS of Rogers DUROID gasket materials assure even compressibility over entire surface of the packing. Now your allowances for gasket thicknesses can be actual — not wishful — and fastening torques can be standardized, an advantage that gains in importance as assembly operations are increasingly mechanized.

MADE BY THE BEATER SATURATION METHOD, a manufacturing technique in which Rogers has maintained leadership since 1932, DUROID gasket materials are thoroughly mixed in a water slurry. Asbestos fibres are blended with the rubber to form a homogeneous sheet, free of pressure-weak lumps of uncoated fibre.

OFFERING AN AMAZINGLY HIGH RATIO of tensile strength to density, DUROID gasket sheeting is available in three series of materials. In each series, formulations can be varied quite easily to meet specific requirements for compressibility and recovery.

You can specify ±.002" for thicknesses up to .031" and ±.003" for gauges up to ⅛", for most grades.

DUROID 3100 SERIES — Neoprene-base asbestos recommended for use with oil, gasoline, freon and in water systems with anti-freeze. DUROID 3102 conforms with Spec. MIL-G-7021, Class 2 and AMS 3231.

DUROID 3200 SERIES — Buna-N and asbestos recommended for oil, aromatic and non-aromatic fuel systems in which high temperatures and high pressures will be developed. DUROID 3200 conforms with AMS 3232F requirements.

DUROID 3300 SERIES — GR-S and asbestos recommended for water, anti-freeze and steam systems. Will swell in oil or gasoline applications.

FOR ALL GRADES
Gauges: .015" to ⅛". Sheet size for .015" is 25" x 72"; for all other gauges sheet size is 50" x 72".

Rogers supplies DUROID gasket materials in sheets or in fabricated form, plain or graphite-coated. For test data, please write Dept. E, Rogers Corporation, Manchester, Conn.

Better Parts for Better Products

ROGERS
CORPORATION
Established in 1832

YOU NAME IT — WE'LL MAKE IT — AND FABRICATE IT, TOO

DUROIDS for Gaskets, Filters Electronics . . .

ELECTRICAL INSULATION for Motors, Transformers, Generators . . .

PLASTICS Molding Compounds and Laminates

SHOE MATERIALS for Counters, Midsoles, Liners

YOU SAVE WHEN ROGERS FABRICATES FINISHED PARTS

HOT UNDER THE COLLAR . . .

But This Special Purpose BREEZE Clamp WON'T BLOW its TOP!

Heavy corrugated band for extra strength.
Heavy stainless steel welded lugs.
Hex nut for high torque tightening.
Bolt safety-fastened—can't get loose.

Special Purpose Clamps by Breeze.

A jet engine exhaust is a volcano of heat, pressure and vibration. The clamp that goes around it must withstand these conditions—and *hold tight.*

Breeze makes a clamp for this exacting use, and for a wide variety of other applications where stock items just won't do.

Just as Breeze AERO-SEAL hose clamps have set higher quality standards in their class, so Breeze fabricated-to-order clamps have the extra strength and other properties for every special use. Any design, any metal, any quantity. Tell us your clamping problems.

OTHER BREEZE PRODUCTS
Flexible Metal Tubing and Conduit
Aircraft Actuating Systems
Special Drives and Gear Boxes
Special Electrical Connectors
Metal Bellows, Ignition Shielding.

BREEZE

ANOTHER BREEZE PRODUCT

CORPORATIONS, INC.

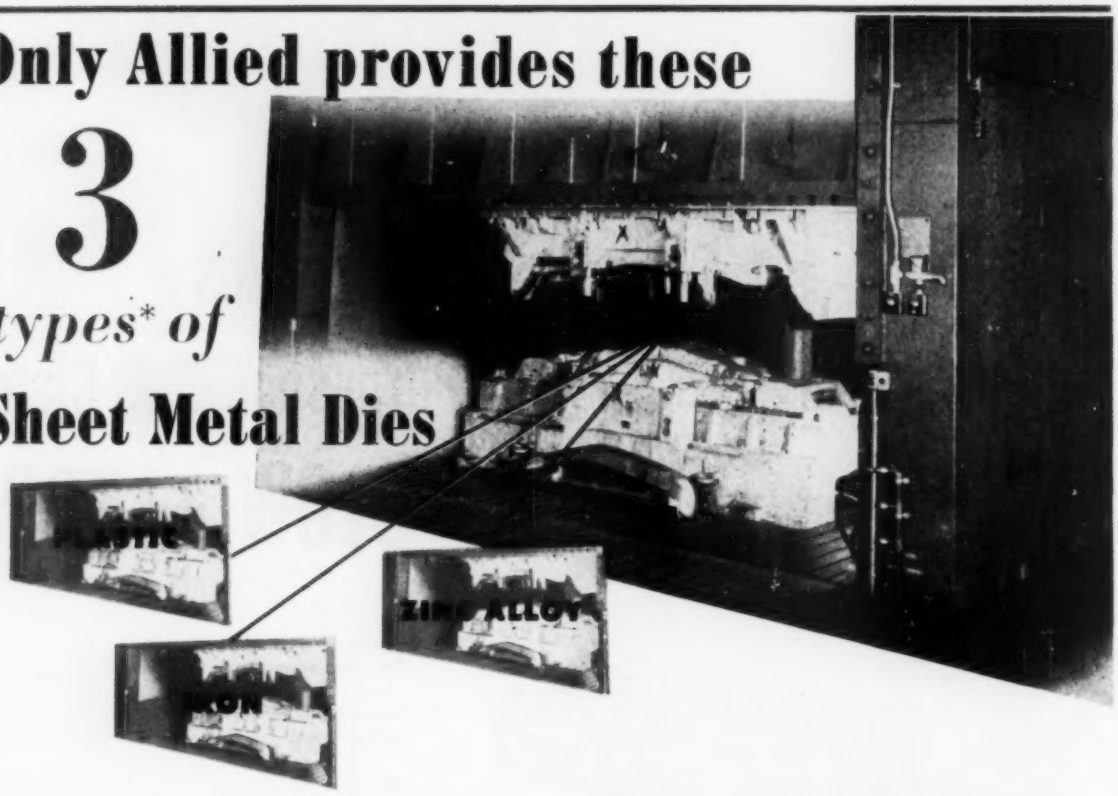
41 South Sixth Street, Newark 7, N. J.

Only Allied provides these

3

types of*

Sheet Metal Dies



To Give You the Best Die...The Most • Economical Die...for Your Production

**Combinations of materials are also used.*

Other Allied Products

SPECIAL COLD FORGED PARTS • STANDARD CAP SCREWS • HARDENED AND PRECISION GROUND PARTS • R-B INTERCHANGEABLE PUNCHES AND DIES

How can a *complete* sheet metal die service, such as Richard Brothers Division offers, result in substantial time and cost savings for you?

Suppose you have a few experimental parts to produce. Here a die made of Rezolin Tool Plastik may prove to be the answer. As this material does not shrink or expand, it permits fast, low-cost production of accurate dies. Where production runs exceed the limitations of plastic dies, yet still are not in very high volume, Allite zinc alloy dies can be used—again with savings of time and money by comparison with hard dies.

When the parts are required in high volume, the experience gained in the use of the plastic or zinc alloy dies is applied in the manufacture of the production dies. The true die conditions demonstrated in short-run production make possible a direct approach to building the long-run dies, with resulting savings in development, finishing and tryout.

Here at Richard Brothers Division—under one roof—you have a sheet metal die service that is unique—that can be put to work for you to cut your production costs. Why not investigate its possibilities . . . today?

PRECISION • EXPERIENCE • DEPENDABILITY

ALLIED CORPORATION PRODUCTS

ALLIED PRODUCTS CORPORATION

DEPT. D-13 • 12639 BURT ROAD • DETROIT 23, MICH.

PLANT 1
Detroit, Mich.

PLANT 2
Detroit, Mich.

PLANT 3
Hillsdale, Mich.

PLANT 4
Hillsdale, Mich.

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

Specify

Eastman

first in the field

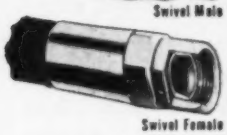
HYDRAULIC HOSE ASSEMBLIES

for the best performance, for long life and satisfaction—*all along the line*—from manufacturer to user. Check your needs on the following list:

COUPLINGS

Solid Male

Swivel Male

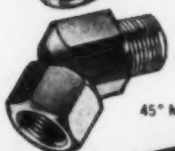


Swivel Female

STRAIGHT AND ANGLED ADAPTER UNIONS

Straight Male

90° Male



45° Male

Write

for free catalog 103 on Eastman Hose Couplings and Bulletins 231B & 232B on Straight and Angled Adapter Unions.

Hydraulic power

Eastman

"KEEP 'EM DOWN ON THE FARM!"

EASTMAN Hydraulic Hose Assemblies on Massey-Harris Tractor.

Thanks to hydraulic power, many a man's job on the farm is a boy's job now! Fingertip hydraulic control does away with aching arms, dog-tired from day-long tugging at levers to raise and lower tillage tools.

Massey-Harris, shipping agricultural tractors and implements to 106 countries the world over, has developed some of the most ingenious hydraulic controls to meet the needs of modern contour farming—controls which not only do most of the hard work—*but do it automatically!*

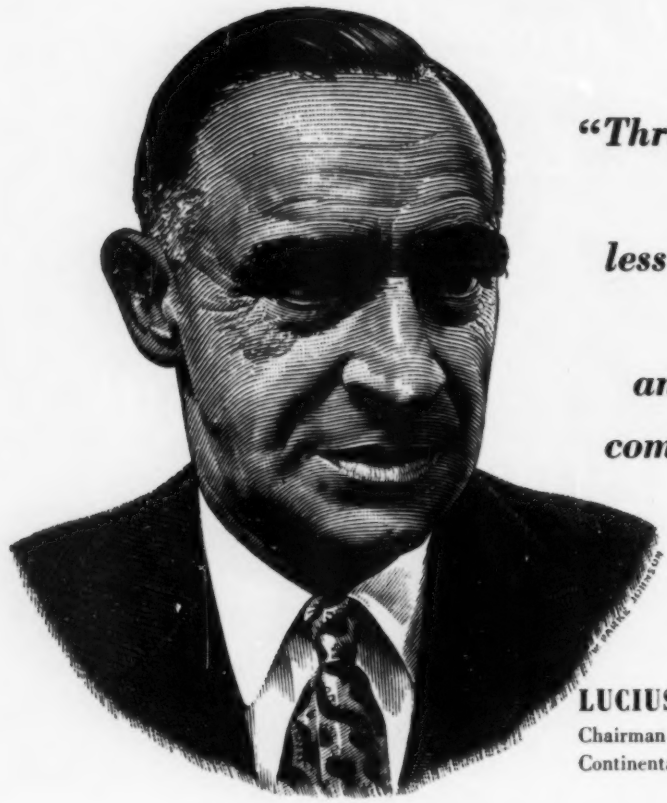
EASTMAN Hydraulic Hose Assemblies carry oil at 1000 psi from the Massey-Harris 2-Way, 2-Speed *"Depth-O-Matic"* Hydraulic Control to raise and lower tractor mounted implements smoothly, easily, swiftly. Synchronized slave cylinders handle harrows, discs, plows.

Massey-Harris *"Selective Control"* maintains uniform cultivator penetration on hillside contour slopes, pictured above, through independent action of right and left gangs. *"Delayed Action"* permits raising front and rear gangs independently at contour points, also permits shovels to leave and enter soil at same point at ends of rows.

Other users of EASTMAN Hydraulic Hose Assemblies in the agricultural field include: Allis-Chalmers Mfg. Co.; J. I Case; John Deere Co.; The Farmhand Co.; Harry Ferguson, Inc.; Horn Manufacturing Co.; International Harvester Co.; Minneapolis-Moline Co.; Ottawa Steel Products Co.; Super-Six Manufacturing Co.; A. F. Wagner Iron Works.

Look to EASTMAN—first in the field—for continued leadership in "Safeguarding the Lifelines of Mobile Power"—in Industry and Agriculture!

Eastman



"Thrifty citizens . . . with Savings Bonds . . . less likely to be taken in by the false promises and ideologies of communist propagandists . . ."

LUCIUS D. CLAY
Chairman of the Board
Continental Can Company

"The regular purchase of Savings Bonds through the Payroll Savings Plan by millions of our citizens contributes importantly to the country's economic stability, the national defense effort, and to the financial independence of the individual. The thrifty, self-reliant citizen is one far less likely to be taken in by the false promises and ideologies which communist propagandists invariably direct to the 'have nots'."

• To thousands of company executives, accountants, payroll department employees, PSP means Payroll Savings Plan, the simple payroll allotment operation through which employees make a monthly investment in U. S. Savings Bonds.

• To almost eight million employees of nearly 50,000 companies, PSP has a more intimate connotation. To them, PSP spells *Personal Security Plan.*

• Multiply the personal security of a single Payroll Saver by 43,000,000—the number of individuals who hold Savings Bonds having a cash value of $49.5 billion—and you have economic stability that is the keystone of our national defe. e.

• Thanks to the thousands of companies which offer their employees the Payroll Savings Plan, Bill Brown in the Machine Shop . . . Joe Green in the boiler room . . . and eight million more Browns and Greens can well turn a deaf ear to ". . . the false promises and ideologies . . ." of communist propagandists. Bill can see his new home taking shape in his growing stack of Savings Bonds . . . Joe sees each bond another step toward a college education for little Joe . . . and the "Old Timer," who eats his lunch with Bill, talks of "sitting down pretty soon" because his Bonds will make a nice addition to his Social Security.

• PSP holds still another benefit—this one for the employer. Payroll Savers are conscientious workers. Statistics show that absenteeism goes down, production improves and accidents decrease as payroll participation goes up.

• If employee participation in *your* Payroll Savings Plan is less than 50%—or if your company does not have a Payroll Savings Plan—get in touch with Savings Bond Division, U. S. Treasury Department, Washington Building, Washington, D. C. Learn how easy it is to help your country, your employees and your *company*—through the PSP.

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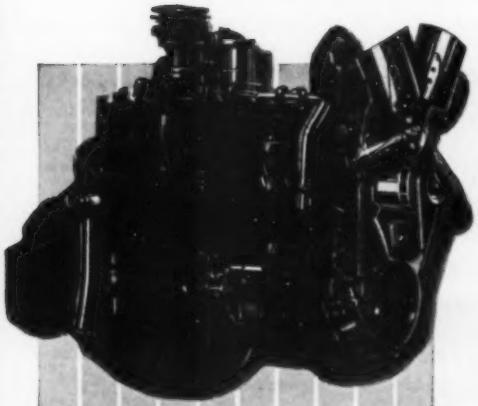
Product Engineering

Photo courtesy Massey-Harris Co., Ltd., Toronto, Ontario, Canada.

Chrysler powers 70-acre-a-day combine



"'King-size' for today's 'king-size' grain crops" . . . that's one way you might describe this new self-propelled combine shown here hard at work in a wheat field. It has a sixteen-foot, hydraulically controlled auger table and cutting bar which picks up and cuts in any of three widths. Extra-capacity rub bars and straw walkers help assure more complete threshing. Covers plenty of territory with maximum speed of more than fourteen miles per hour, hydraulically controlled through variable speed drive.

To power this combine, Massey-Harris uses the mighty Chrysler Industrial Model 8 Engine with 250 cubic inches displacement. In other Massey-Harris combines the slightly smaller Industrial Model 5 Engine is used. By so doing, this manufacturer makes certain that his combines will give top-notch performance—the kind farmers can depend upon to get in their valuable crops year after year.

Manufacturers select Chrysler Engines *equipped* to meet their needs. For example, they can have engines with standard or gear-driven front ends (with magneto or hydraulic pump drive), twelve or twenty-four volt electrical systems, standard, gyrol Fluid Coupling or torque converter transmissions.

They find too that Chrysler-Industrial Power is not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices.

See the nearest Chrysler Industrial Engine Dealer or write:

Dept. 48, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.

CHRYSLER
Industrial Engines

HORSEPOWER **WITH A PEDIGREE**

BETTS MACHINE COMPANY

lights the way to lower costs with—

PARKER DIE CASTINGS

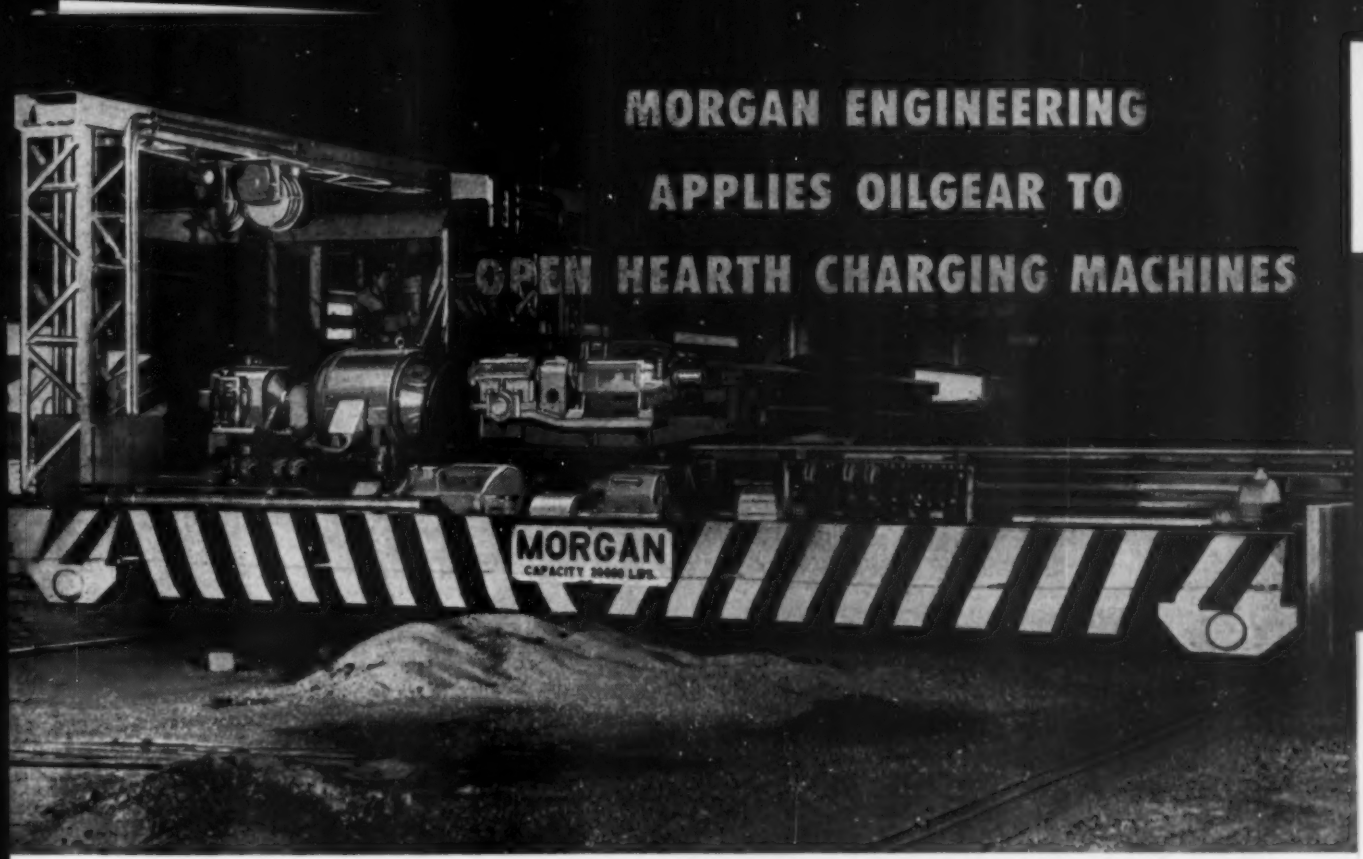
BETTS MACHINE COMPANY, Warren, Pa., is using Parker Die Castings for the *housing* and *hex nut socket* on their Truck Clearance Lights. These lights are pressure tight and "bubble-proof" thanks to Parker's ability to provide leak proof and non-porous die castings. Die castings were also selected because they eliminate machining—to lower production costs. For more than fifty years Parker die castings have been specified by manufacturers in industry . . . automotive, aviation, electrical, business machines and many others. The experience thus gained by Parker can be used to your benefit. Consult with Parker engineers on your next die casting requirements.

and when you think of Die Castings THINK OF

Parker White-Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER ALUMINUM *and* ZINC *Die Castings*

MORGAN ENGINEERING APPLIES OILGEAR TO OPEN HEARTH CHARGING MACHINES



Gains Longer Life, Greater Visibility, Safety and Simplified Design

It has been said that for a number of years very few improvements have been made in open hearth charging machines used in steel mills. Here too a consideration of Oilgear Fluid Power equipment led to some valuable and important progress.

The Morgan Engineering Company, a leading manufacturer in the field, decided that much could be gained by the use of oil hydraulics and designed its 10-ton charging machine accordingly. Morgan uses the following Oilgear Fluid Power equipment: a hydraulic pump with a volume of 60 gallons per minute at 1700 psi pressure; 2 hydraulic cylinders for the hoist; one cylinder for the peel clamping device; two 4-way control valves located near the pump operated in turn by two pilot valves in the operator's cab; and a cam operated relief valve on the peel clamping device.

The company gained the following advantages: on the hoist, the conventional large hoist motor with its reduction unit is eliminated giving the operator maximum visibility and of course surer operation. The hydraulic cylinders used eliminate the conventional crank motion used hitherto exclusively.

The peel clamping device is actuated by one hydraulic cylinder, felt to be a definite improvement. It was found that hydraulic clamping is adequate by itself and the usual locking device was eliminated. More important, hydraulic clamping prevents oscillation of the boxes while the peel is being rotated and this prolongs the life of both peel head and boxes.

The cam operated relief valve is a safety measure, preventing the operator from lifting the box until the locking rod has been correctly located in the box head well.

Since this application has proved so satisfactory, the Morgan Engineering Company has applied Oilgear Fluid Power Equipment to other types of charging machines, to hot saws, inverted and portable strippers as well.

Designers should bear in mind the advantages cited above are in addition to the fundamental Oilgear advantages of flexibility, wide range of power, infinitely and steplessly variable speed range, unlimited ratios, smooth cushioned acceleration and shockfree hydro-dynamic braking, simplified and accessible hydraulic design well ahead of J.I.C. standards, a range of application from the handling of the most delicate and fragile webs up to the most massive power requirements. You are invited to submit your problem to Oilgear. It will cost you nothing to do so; it may prove to be one of the most profitable steps you have ever taken. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wisconsin.

OILGEAR

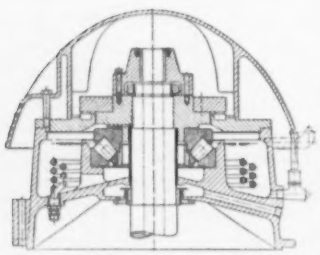
OILGEAR

Highest anti-friction capacity for VERTICAL SHAFT applications

The SKF Spherical Roller Thrust Bearing is becoming more and more popular as the means of supporting heavy thrust loads at high speeds. Vertical shaft applications demand bearing engineering which is abreast of the newest developments in equipment design.

Here is *why* the SKF Spherical Roller Thrust Bearing is earning increased application with manufacturers everywhere:

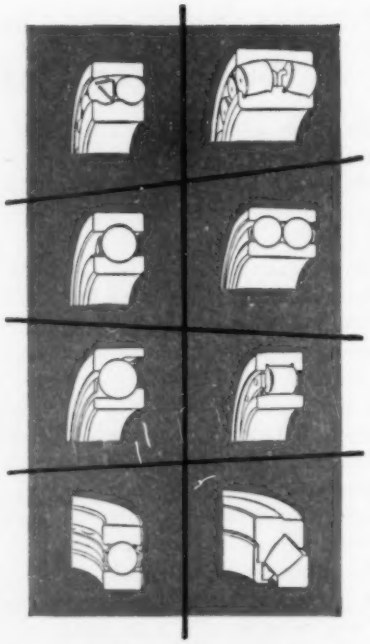
- The bearing has very high capacity for thrust loads, and combined loads which are predominantly thrust.
- It is fully self-aligning—has a single row of rollers which roll on a spherical outer race with full self-alignment.
- The bearing design is such that the lubricant is pumped outwardly against the inner ring high guide flange—thereby insuring perfect lubrication and long, trouble-free life.



The drawing shows a typical application of the SKF Spherical Roller Thrust Bearing—providing higher *capacity*, size for size, than any available design.

When you're laying-in anti-friction bearings, you can get design assistance and help from SKF Field or Home Office men who know the best ways to do the job in every industry. And, when you have a bearing replacement to make, call your SKF Distributor. 7435

SKF INDUSTRIES, INC., PHILA. 32, PA.,— *manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.*

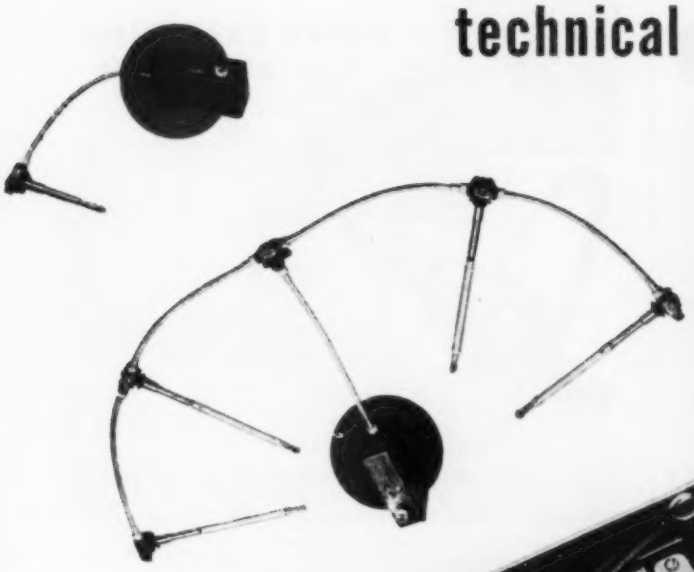


SKF'S COMPLETE LINE OF ANTI-FRICTION BEARINGS, PLUS SKF ENGINEERING CO-OPERATION, HELPS YOU *PUT THE RIGHT BEARING IN THE RIGHT PLACE.*

SKF®

BALL AND ROLLER BEARINGS

technical bulletin by EEMCO



UNIVERSAL POWER PACKAGE HAS MANY APPLICATIONS

TECHNICAL DATA

Weight, complete — 3⅜ lbs.

Dimensions — 7⅛" x 4 7/16" x 2¾"

Operates in ambient temperatures up to 250° F.

Conforms to AN-M-40 and latest MIL. specs.

EEMCO helps you build for the future

Completely self-contained . . . This rotary actuator package, designed and built by EEMCO, combines the following elements in an integral metal container: Motor . . . radio noise filter . . . magnetic clutch and brake . . . main gear reduction driving power take-off for operating aileron and elevator trim tabs. Auxiliary gearing operating adjustable limit switches to control travel, light switches and position indicator.

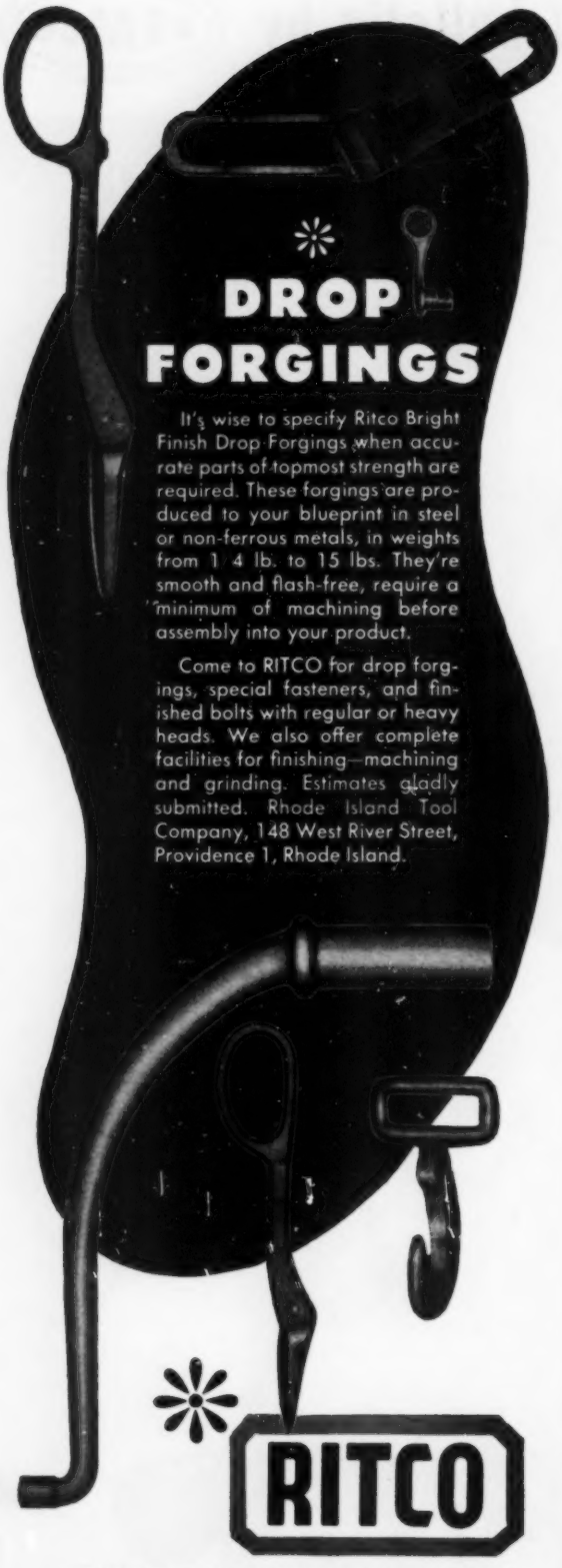
Versatile . . . A few of the many possible power unit screw jack combinations are illustrated. It can also serve to drive rotary or linear type actuators through a flexible shaft in difficult installations where space will not permit complete linear or rotary actuator units.

Variable power and speed . . . Changes in motor winding, lamination stack length and gear ratios permit a wide variation in power and speed without modification of the package. Variations in positioning and indicating are possible by change of gear ratios in auxiliary gear box.

Mounting bracket and AN receptacle can be located in various positions on the container to provide additional flexibility.

ELECTRICAL ENGINEERING AND MANUFACTURING CORP.

4612 WEST JEFFERSON BOULEVARD • LOS ANGELES 16, CALIFORNIA



DROP FORGINGS

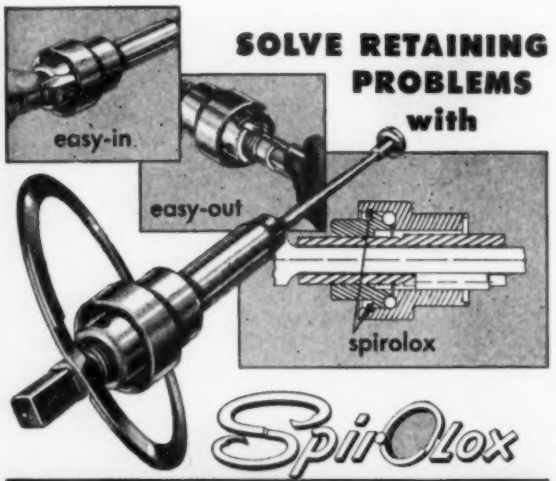
It's wise to specify Ritco Bright Finish Drop Forgings when accurate parts of topmost strength are required. These forgings are produced to your blueprint in steel or non-ferrous metals, in weights from 1/4 lb. to 15 lbs. They're smooth and flash-free, require a minimum of machining before assembly into your product.

Come to RITCO for drop forgings, special fasteners, and finished bolts with regular or heavy heads. We also offer complete facilities for finishing—machining and grinding. Estimates gladly submitted. Rhode Island Tool Company, 148 West River Street, Providence 1, Rhode Island.

RITCO

EXCLUSIVE NEW ENGLAND REPRESENTATIVES FOR CLEVELAND CAP SCREWS

★ SERVING AMERICAN INDUSTRY SINCE 1834 ★



SOLVE RETAINING PROBLEMS with

SpirOlox Retaining Rings

With Spirolox you are assured of quick, easy installation and removal of the retaining ring. As illustrated by this installation on a tube-cutter assembly, Spirolox is inserted in a jiffy, removed with a flip of a screwdriver. No special tools needed.

Simplified, trouble-free solutions to retaining problems like this are possible because of extraordinary Spirolox flexibility and conformability. Unique two-turn construction lets you spiral-in a Spirolox ring quickly and easily. Complete elimination of lugs or projections, breaks or gaps, provides uniform shoulder which conforms 100% to diameter of groove.

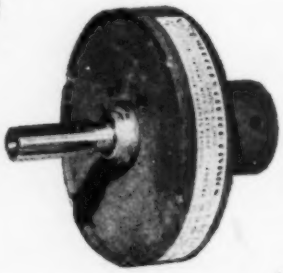
SEE OUR CATALOG IN SWEETS FOR PRODUCT DESIGNERS

FREE DATA BULLETIN tells how you can solve toughest retaining problems with SPIROLOX—send for your copy! Ramsey Corporation, St. Louis 8, Missouri, a subsidiary of Thompson Products, Inc. 108

U. S. Pat. No. 2,450,425 and Foreign Pats. Other Pats. Pend.

SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!

DESIGN PROBLEMS BOTHERING YOU?



Frequently it is possible to eliminate the problems in a new design by specifying a MERCURY clutch. Operating thru hydraulic pressure and centrifugal force, MERCURY clutches assure

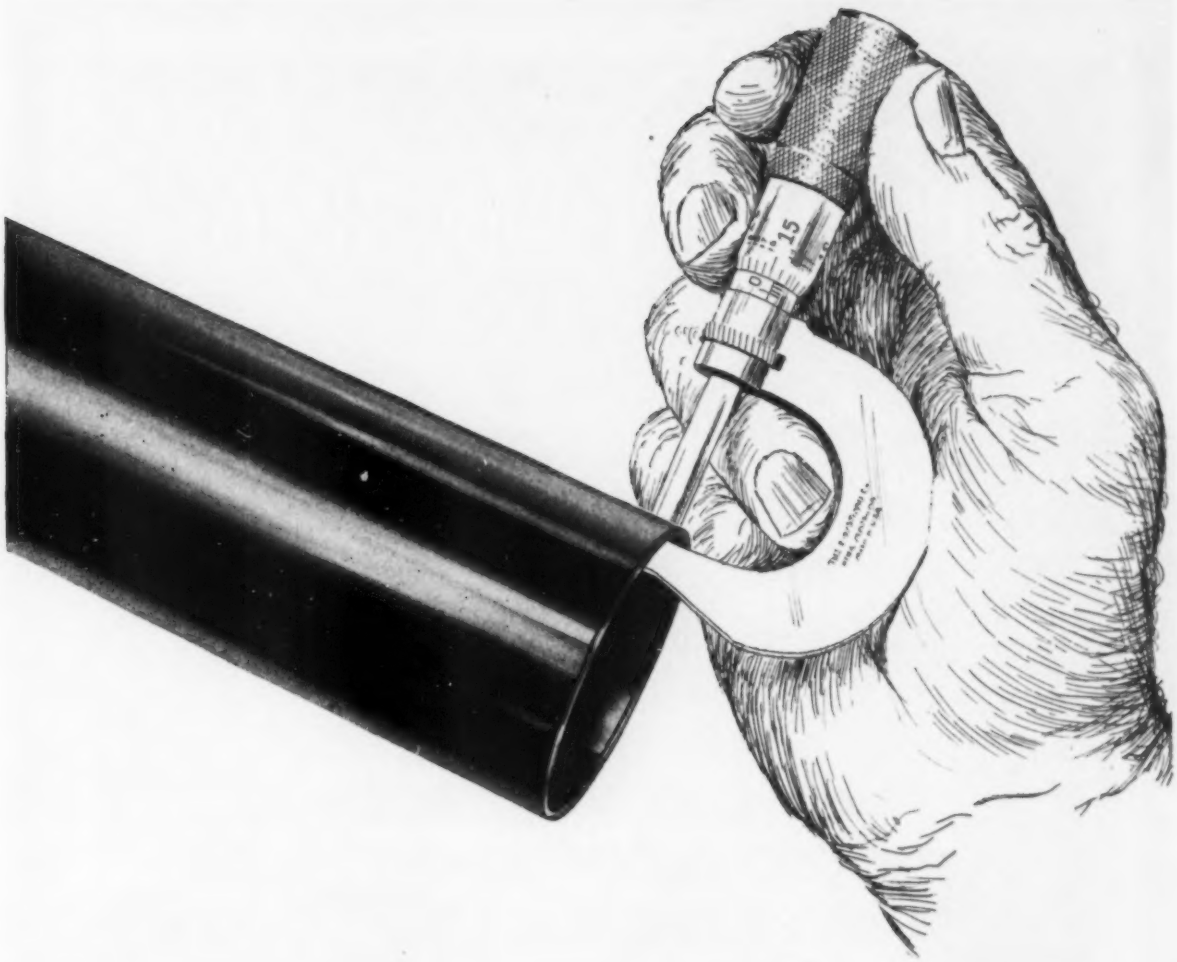
- **The automatic controlled application of torque to the driven load**
- **High starting torque—eliminating "overpowering"**
- **Smooth load pick-up without grab or chatter**
- **Reduced starting current demand**

On all electric or gas driven equipment—put your clutch problems up to men who know clutches best—MERCURY engineers.

Write today for full information.

Mercury has the Answer!

Mercury Clutch Division
AUTOMATIC STEEL PRODUCTS, INC.
CANTON 6, OHIO



It has to be accurate ...it's welded tubing

• Since welded tubing is formed from flat strip, the wall thickness must be uniform throughout. This advantage is so well recognized that tolerances for wall eccentricity are not commonly included in specifications.

Brainard welded steel tubing is an economical structural material, and it offers many such physical advantages. Can it cut costs or reduce weight in *your* product designs? For complete information write Brainard Steel Division, Dept. GG-8, Griswold Street, Warren, Ohio. An integrated producer; offices throughout the U. S.

Brainard
SHARONSTEEL
STEEL DIVISION
SHARON STEEL CORPORATION

WELDED STEEL TUBING

Among other obligations...

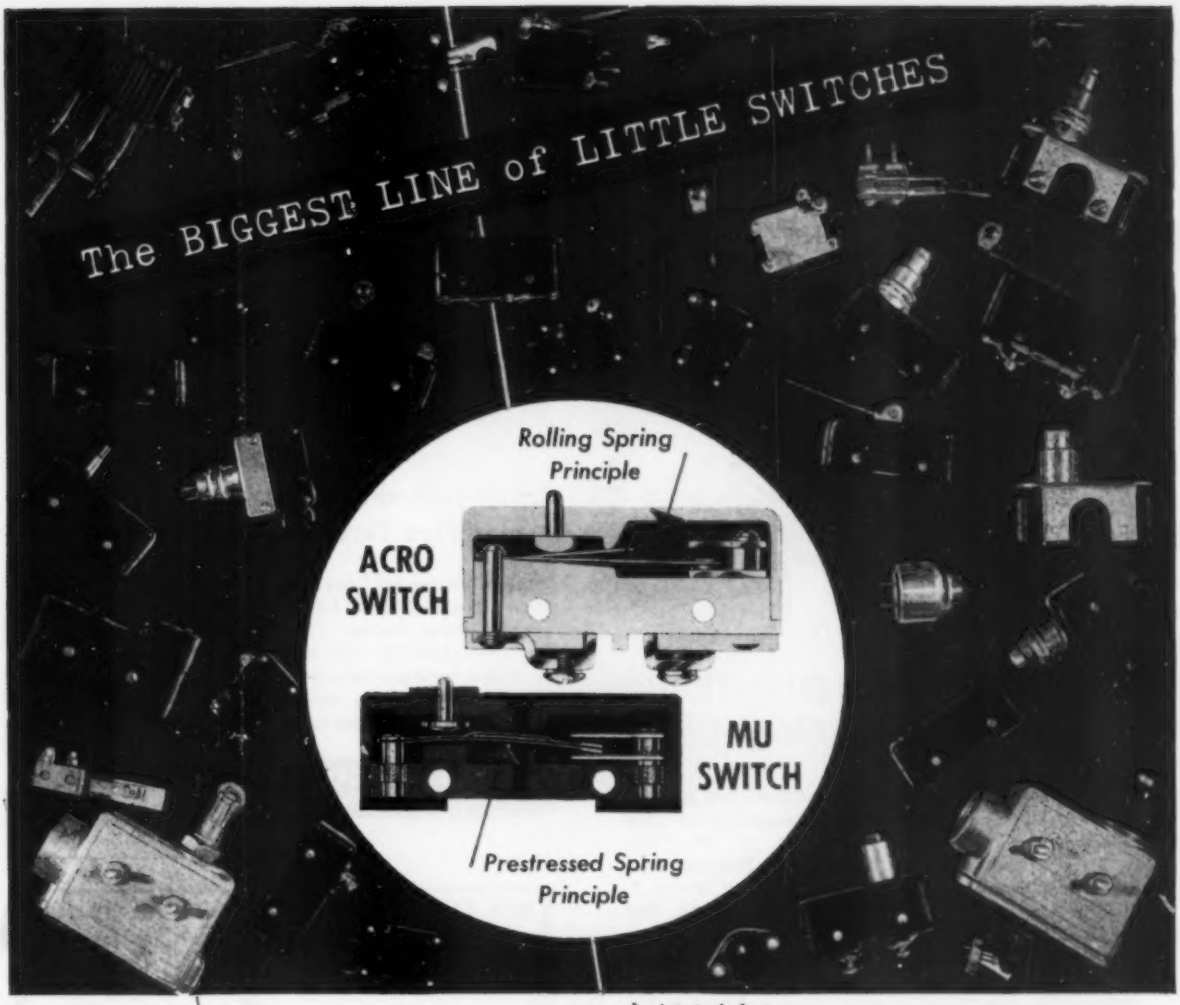
When an order is accepted the obligation to supply the commodity as stated in the contract is routine. But every purchaser knows that there are many other and additional services that the seller can render which serve the convenience and interests of the customers.

Along with every order accepted by the Bunting organization is also accepted the obligation to cooperate with the customer as well as to deliver the items as specified.

Ask *any* Bunting customer.

The sleeve bearing is not complex in structure; it conforms readily to design requirements; it is easily installed. Cast Bearing Bronze is the most adaptable of all sleeve bearing materials; it possesses excellent anti-friction properties. With proper film lubrication, its coefficient of friction is as low as can be obtained with any other bearing type. A successful Bunting Bronze bearing installation is readily attainable. We ask the opportunity to work with you, and to quote on your requirements.
Bunting
BRONZE BEARINGS • PRECISION BRONZE BARS • BUSHINGS

THE BUNTING BRASS & BRONZE COMPANY • TOLEDO 1, OHIO • BRANCHES IN PRINCIPAL [illegible]



A GREAT NAME IN ELECTRICAL SWITCHES

SNAP ACTION

In the complete Acro-Mu line there can be found every conceivable type, size and rating in miniature precision snap action switches. There are over 7000 specifications to choose from. And since Acro makes more types of standard switches than anyone else, you can probably find the switch you need for your particular application right in our catalog. If not, our skilled engineers will gladly work with you to develop it economically.

We have recently completed an expansion and modernization program at our plant in Columbus. Further expansion is underway in our construction of the world's most modern precision switch plant. We are ready to serve you from the biggest line of precision, miniature snap action switches, made to the highest quality standards.

Write today for up-to-date catalogs.

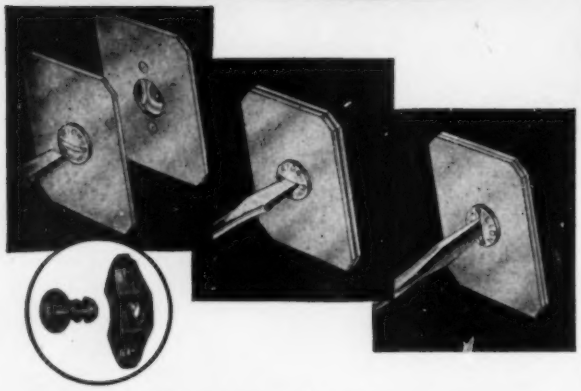
ACRO MANUFACTURING COMPANY

COLUMBUS 16, OHIO

COIN SWITCHES, OPEN BLADES, PHENOLIC ENCLOSED, METAL CLAD, MINIATURES, HIGH VOLTAGE, D.C., PUSH BUTTON, PANEL MOUNTS

For Parts that must be TAKEN OFF–PUT BACK–BUTTONED TIGHT

LION FASTENERS



LOCKS TIGHT WITH A QUARTER TURN
Always at correct tension

Lion Fasteners are *right* for buttoning parts that must be removed repeatedly for inspection, maintenance, or other reasons.

Vibration and shock can't loosen a Lion Fastener. Even an inexperienced service man can't replace it wrong. A quarter turn opens it. Another quarter turn locks it. The tension is designed *into* it.

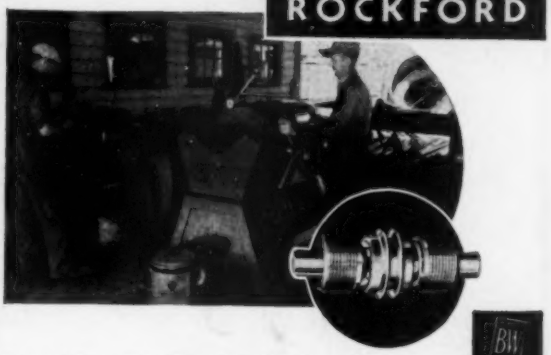
Lion Fastener Spring Assembly is quickly spot welded or riveted in place. The stud cannot be lost. It is grommeted tight to the sheet. They will button sheets .040 plus or .020 minus over or under standard rating. The misalignment is as much as .156. The one-piece forged stud is tested to 1425 lbs. Write today for demonstration kit and application data.

TYPICAL APPLICATIONS: INSPECTION PLATES • COWLING • ELECTRICAL PANELS • CABINETS • DUCTWORK

Free DEMONSTRATION KIT contains sample Lion Fasteners to help you visualize their adaptability to your product. Write on your company letterhead. No obligation.

LION FASTENERS, INC.
300 Main St., Honeoye Falls, N.Y.
IN CANADA A.T.R. ARMSTRONG CO., 50 ST. CLAIR AVE., WEST, TORONTO

CLUTCHES by ROCKFORD

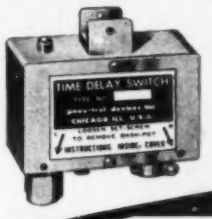


Provides Mechanized "Muscles" for Pipe Threading Jobs

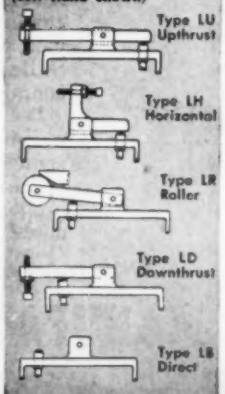
Much of the manual labor has been taken out of pipe threading by the Toledo Pipe Threading machine shown above. And ROCKFORD Pullmore CLUTCHES help it handle this operation much faster and better than previous cutters. Let ROCKFORD help modernize the power transmission control design for *your* next model.

ROCKFORD CLUTCH DIVISION BORG-WARNER
209 Catherine Street, Rockford, Illinois, U. S. A.

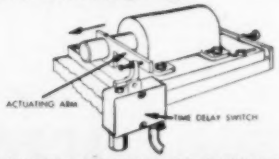
NEW CYLINDER TIME DELAY CONTROL SWITCH INCREASES APPLICATION . . . WIDENS USE OF CYLINDER POWER



For Any Type Actuation Left or Right Hand (Left Hand Shown)



Pneu-Trol Time Delay Switches provide independent hydraulically controlled adjustable time dwell between ¼ and 60 seconds in 20 to 1 ratios. Readily mounted on machine for cylinder dwell at a positive stop. Compactly designed—a simplified low cost answer to electrical time dwell control of any air or hydraulically operated machine movement such as press work, burnishing, coating, quenching, metal-cutting, etc. Ideal for automatic feeders. Dimensions: 4⅛" wide; 2⅜" high; 1-7/16" deep. Overall height 4⅛".



SWITCH MOUNTED TO PROVIDE DWELL AT END OF POWER STROKE

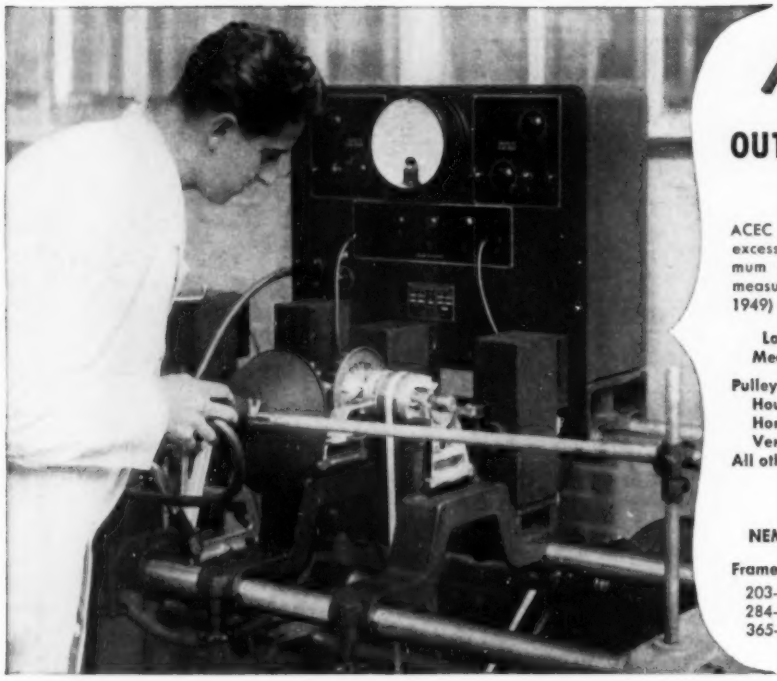
Write for descriptive literature and complete details.

PNEU-TROL DEVICES, INC.
1430 N. Keating Ave. Chicago 51, Illinois

McLouth
STAINLESS
Steel

For the product you make
today and the product you
plan for tomorrow.

McLouth Steel Corporation
DETROIT, MICHIGAN
Manufacturers of Stainless and Carbon Steels



ACEC

OUTSTANDING DYNAMIC BALANCE

ACEC Motors are dynamically balanced far in excess of NEMA standards at no extra cost. Maximum amplitude of vibration of ACEC Motors measured according to NEMA-MGI-4.21 (Oct. 1949) specification.

Location of Measurement	3 HP 1800 RPM	5 HP 1800 RPM
Pulley End Bearing Housing:		
Horizontal Amplitude	0.00035	0.00025
Vertical Amplitude	0.00025	0.00025
All other parts of Motor	0.00020	0.00015 to 0.00020

NEMA (MGI-4.20) Recommended Standard

Frame Sizes	Amplitude in Inches
203-254	0.00100
284-364	0.00150
365-505	0.00200

THESE QUALITY + FEATURES SHOW WHY ACEC MOTORS DELIVER BETTER PERFORMANCE

Dynamic balancing far in excess of NEMA Standards, as shown above, practically eliminates vibration. Equal loa ' distribution on bearings obtained in ACEC design greatly prolong life of these bearings—assures a longer lasting, smoother running motor *at no extra cost to you.*

Tightly sealed bearing enclosures keep lubricant in and dirt and foreign particles out. ACEC motors operate at any angle.

Rounded stator slots top and bottom assure tighter fitting stator windings—eliminate voids that collect dirt and moisture, shorten insulation life.

"Baked-on" insulation. Oven-dried polyvinyl-acetal insulated windings receive two additional coats of "baked-on" plastic insulating varnish for maximum dielectric strength.

Simple, rigid assembly results from cast iron frame and end shields and use of 4 through-bolts with 8 nuts. End shields can be removed without disturbing bearings on shaft.

Rigid quality control maintains quality of materials used in ACEC motors within the narrowest limits. Every motor receives thorough testing—carries a factory guarantee.

ACEC Motors offer these and many other quality features, *yet they're priced below most other motors.* Manufactured strictly to NEMA Frames and Specifications by one of the world's largest electrical manufacturers, they are available in a wide variety of types from **300 ACEC Distributors and Service Shops** across the nation.

No matter what your motor requirements, it will pay you to investigate ACEC's top-level performance *at lower prices* by writing to the addresses listed below.

Open Drip Proof ACEC MOTOR

BELGIAN ELECTRIC SALES CORPORATION

New York City: 40 E. 49th St. PLaza 8-3105

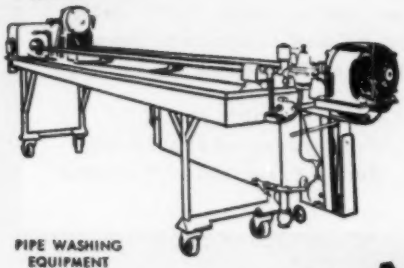
Los Angeles: 423 E. 3rd St. MAdison 6-4421

Sales Engineers & Agents in Principal Cities

CHARLEROI ACEC

ACEC Motors

WHAT are your Valve Needs?



PIPE WASHING EQUIPMENT

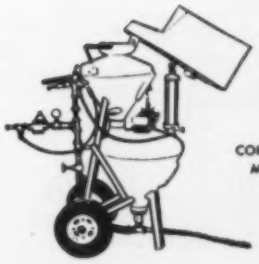
CASH-ACME HAS THE Answer!

AIR VISE

Rising costs—delivery—are they affecting the quality of your finished product? If pressure control is a vital part of its operation, make sure the valve selected is a CASH-ACME. If you do not find the specified valve required, let CASH-ACME's staff of engineers study your problem and make their recommendation. There is no obligation.

Mail the coupon below with a brief outline of your installation requirements. A free booklet or catalog on request.

SEPARATOR PARTS WASHER FOR DAIRY



CONCRETE MIXER

CASH ACME

SILENT SENTINEL *Automatic Valves*

A. W. CASH VALVE MFG. CORP.
6662 E. Wabash Avenue • Decatur, Illinois

ATTACH TO YOUR LETTERHEAD

A. W. Cash Valve Manufacturing Corp.,
6662 E. Wabash Avenue
Decatur, Illinois

☐ Please send me your free booklet.

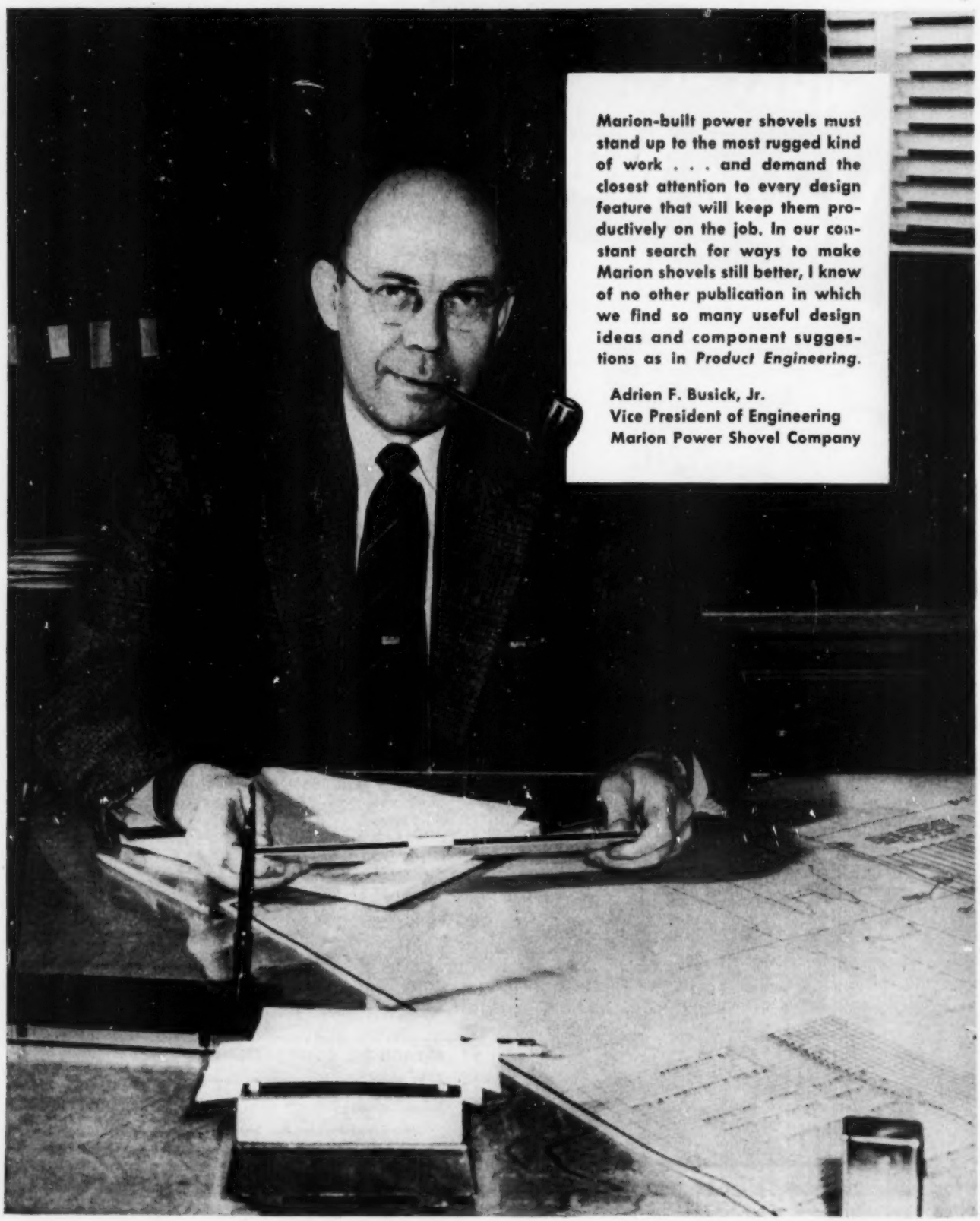
NAME_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

To save time may we suggest a brief outline of your requirements be mailed with this coupon.



Marion-built power shovels must stand up to the most rugged kind of work . . . and demand the closest attention to every design feature that will keep them productively on the job. In our constant search for ways to make Marion shovels still better, I know of no other publication in which we find so many useful design ideas and component suggestions as in *Product Engineering*.

Adrien F. Busick, Jr.
Vice President of Engineering
Marion Power Shovel Company

THE MEN WHO DESIGN

He Designs Power Shovels

HE READS PRODUCT ENGINEERING

. . . and when you want the interest and attention of design-engineering leaders everywhere in industry, you concentrate your advertising in Product Engineering

You concentrate your advertising here because this is the *only* design-engineering magazine that delivers 24,000 ABC-audited, paid subscribers . . . . and has the *editorial leadership* which attracts such a self-elected, management-concentrated, steadily growing audience of product-design engineers.

Over 800 advertisers and their agencies know how much sales power is generated by *Product Engineering's* exclusive combination of editorial and paid-circulation leadership. Every year, they invest far more advertising pages and dollars in *Product Engineering* than are entrusted to any other design publication.

In 1952, *Product Engineering* carried 1,330 *more* advertising pages than any other design publication. Among America's leading agencies, the preference for *Product Engineering* was equally decisive. Of the 50 agencies that placed the most advertising pages in business and industrial magazines last year, *every one* that placed space in the design-engineering field used *Product Engineering* to sell its clients' products.

Very clearly, when you want more business in the $26-billion Original Equipment Market, *Product Engineering* offers you the proved advertising values of leadership and outstanding advertiser acceptance. Our nearest representative will be glad to give you *all* the reasons why.

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ABP ABC

AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

PECO PRODUCTS

It may seem like kids' stuff to you -

but it requires a high standard of precision die-casting to produce this aluminum furniture

PECO DIE-CASTING MACHINES

School desks and chairs, light, strong, comfortable, are made in thousands to-day by the Educational Supply Association, using PECO Die-Casters in their production. PECO Die-Casting Machines represent the finest result of technical design, embodying, amongst other characteristic features, electrical control which covers every movement of the cycle.

Full description in leaflets, available on request.

THE PROJECTILE & ENGINEERING COMPANY LTD.

ACRE STREET, BATTERSEA, LONDON, ENGLAND S.W.8

Telephone: Macaulay 1212 Telegrams: "Profectus, Clapham, London" Cables: Profectus London

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SKINNER

Solenoid Valves

for air & hydraulic cylinders
fluid shut-off
diaphragm operated equipment
coolant control

M2

BRONZE BODY

M3

"M" SERIES pilot-operated Skinner Valves have extremely fast action, and large capacity on air, inert gas and liquid applications. All internal metal parts are stainless steel or brass. Soft seals prevent leakage — operate in any position — rubber coated, nylon fabric diaphragm for long life — port size ⅛" or ¼", orifice ⅛" — power consumption, 10 watts — continuous duty.

M2 is two-way, normally closed, 5 to 150 p.s.i., weight 3 lbs. **M3** is three-way, normally closed, normally open, or directional flow, 20 to 150 p.s.i., weight 3¼ lbs.

Write for Bulletins No. 493 & 494

Skinner ELECTRIC VALVE DIV.
THE SKINNER CHUCK COMPANY
114 Edgewood Avenue, New Britain, Connecticut

Metron

ANTI-BACKLASH

MINIATURE SPEED CHANGERS WITH HOBBED GEARS!

Single-section unit illustrated ¾ ACTUAL SIZE!

ANTI-BACKLASH Metron Miniature Speed Changers are equipped with precision-hobbed, case-hardened steel gears . . . Ideal for use in precision instruments, counting devices, regulators, controls and other equipment requiring high accuracy in small, light weight fixed-ratio speed changing. Anti-backlash is obtained by spring-loading parallel gear trains against each other, so that backlash is taken up continuously. Write for Bulletin No. 100, containing full specifications and prices.

- **STANDARD RATIOS** from 10/9 to 531,441/1.
- **COMPACT!** Only 1.050" diameter; single-section types only 3 1/16" overall!
- **STAINLESS STEEL** ball-bearing drive shafts, permanently lubricated.
- **SPEEDS** up to 10,000 RPM on high-speed shaft!
- **PROMPT DELIVERY** on all Standard Ratios.

METRON INSTRUMENT CO.
144 Lincoln Street Denver 9, Colorado

Ask for data on other Metron Miniature Components.

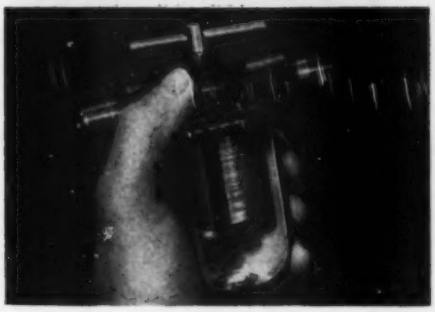
BUILT BY Metron MAKERS OF INSTRUMENTS FOR PRECISION MEASUREMENT

Here's how this strainer "combs" itself clean!

This simple chalk test shows how AUTO-KLEAN's unique built-in comb construction cleans the strainer without costly interruption of flow

ORDINARY BLACKBOARD CHALK leaves heavy deposit of chalk particles on and between discs of Cuno AUTO-KLEAN strainer.

TURNING HANDLE ONE REVOLUTION moves strainer element through comb blades, removing all traces of chalk from between discs. Cuno's exclusive combing operation cleans *thoroughly* —without stopping flow.



FILTERING AREA IS COMPLETELY CLEAN, restoring full initial capacity. All chalk particles and dirt fall to bottom of housing where they can be drained periodically.

- AUTO-KLEAN's permanent metal filter element is available in steel, brass, or stainless steel for long, trouble-free service.
- AUTO-KLEAN is adaptable to any fluid-flow system.
- From acids to tar . . . if you can pump it, Cuno can filter it. Capacities range from one gallon per hour to 15,000 gallons per minute.

CUNO ENGINEERED FILTRATION

Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (disc-type) • MICRO KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound)

SINGLE-STRAINER FLUID PROTECTION ...WITH AUTO-KLEAN

Continuously cleanable AUTO-KLEAN eliminates need for stand-by strainers

Design engineers everywhere are increasing their products' sales potential by incorporating streamlined AUTO-KLEAN strainers in their new products. Here are some of the reasons why:

1. The low pressure drop operation of the AUTO-KLEAN allows *full-flow* service on gravity, low pressure, high pressure or suction lines—with no loss in operating efficiency. AUTO-KLEAN's compact construction provides this continuous, full-flow protection in space which would limit ordinary filters to by-pass service.

2. Cuno's exclusive "comb-clean" action provides complete cleaning of the filter element—*without stopping fluid flow.* Thus, there's no need for providing a stand-by strainer.

3. AUTO-KLEAN's fixed-space metal discs will remove all solids larger than the specified disc spacing—from .0035" up to .062".

4. AUTO-KLEAN's all-metal filter element is *permanent*—lasts as long as the machine on which it's installed.

Follow the lead of the big names in industry and build AUTO-KLEAN into your equipment—it's good design, and good business. Write now for more information.

A.3.8

Cuno Engineering Corporation
Dept. 308A South Vine Street, Meriden, Conn.

Please send me free bulletin on Cuno AUTO-KLEAN for .....
(fluid)

Name.....

Company.....

Address.....

City.....Zone....State.....

"He Might Need It..."

"He never was much for letter-writing when he was in college. But he must know how anxious Mother and I are . . . now that he's off in Korea. Haven't heard from him in six weeks. Of course, they say 'no news is good news' . . . but I wonder. Maybe he can't write . . . because . . . maybe he's in a hospital somewhere. And maybe he needs blood. I don't know . . . but I'm not taking any chances. That's why *I'm* giving blood."

★ ★ ★

Yes, all kinds of people give blood —for all kinds of reasons. But whatever *your* reason, this you can be sure of: Whether your blood goes to a combat area, a local hospital, or for Civil Defense needs—this priceless, painless gift will some day save an American life!

Give Blood Now

CALL YOUR RED CROSS TODAY!

NATIONAL BLOOD PROGRAM

Business Executives!

✓Check These Questions!

If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ☐ Have you given your employees time off to make blood donations?
- ☐ Has your company given any recognition to donors?
- ☐ Do you have a Blood Donor Honor Roll in your company?
- ☐ Have you arranged to have a Bloodmobile make regular visits?
- ☐ Has your management endorsed the local Blood Donor Program?
- ☐ Have you informed employees of your company's plan of cooperation?
- ☐ Was information given through Plant Bulletin or House Magazine?
- ☐ Have you conducted a Donor Pledge Campaign in your company?
- ☐ Have you set up a list of volunteers so that efficient plans can be made for scheduling donors?

Remember, as long as a *single* pint of blood may mean the difference between life and death for *any* American . . . the need for blood is *urgent!*

design puzzles . . .

production puzzles

solve both with . . .

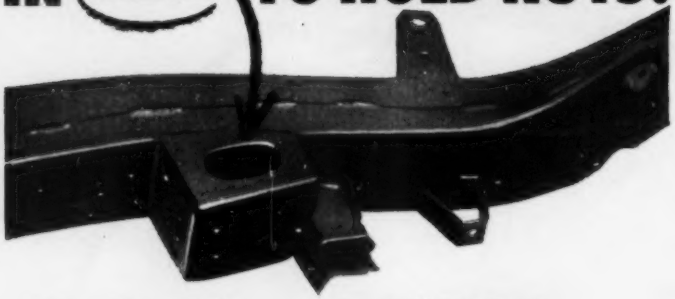
GEROTOR
hydraulic pumps

In many a product . . . on many a production line . . . Gerotor hydraulic pumps have proved to be the one sought-for element, the one most efficient answer to an engineer's problem.

Chances are that a Gerotor can fit into your picture, too. Eleven standard pump sizes . . . plain, base or flange mountings . . . for pressures up to 1200 p.s.i. continuous, 1500 intermittent.

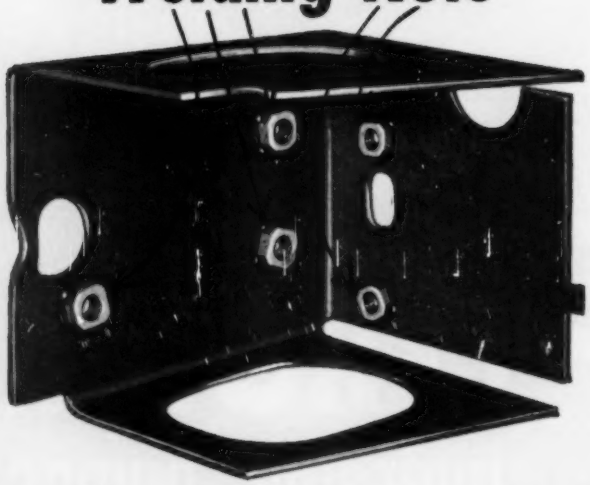
GEROTOR MAY CORPORATION, BALTIMORE 3, MARYLAND

IMAGINE TRYING TO GET IN HERE TO HOLD NUTS!



No Problem At All With . . .

MIDLAND
Welding Nuts



With Midland Welding Nuts pre-mounted* in inaccessible places, there is no need to hold the nuts while attaching other parts.

*THIS IS ALL YOU DO — Just insert collar of Midland Welding Nut in hole for bolt or screw, resistance weld the Nut in place, and the Nut is there for the life of the job. Nuts can be fed automatically to the resistance welder.

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STRAIN GAGE TRANS-DUCERS

For Measurement and Control

This 28-page Special Editorial Report from our November 1952 issue will give you the most up-to-date details on strain gages and this design tool's great versatility.

The first of five sections in this special report covers the two classes of gage—bonded and unbonded, types of bridge circuit, amplifying and recording equipment and the systems combining these components. The four remaining sections take up the different types of transducers designed specifically for measuring pressure, flow, weight and displacement. Case histories follow each transducer section to illustrate some of the more unusual applications for strain gage transducers.

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U. S. MOTORS ASBESTOS-PROTECTED

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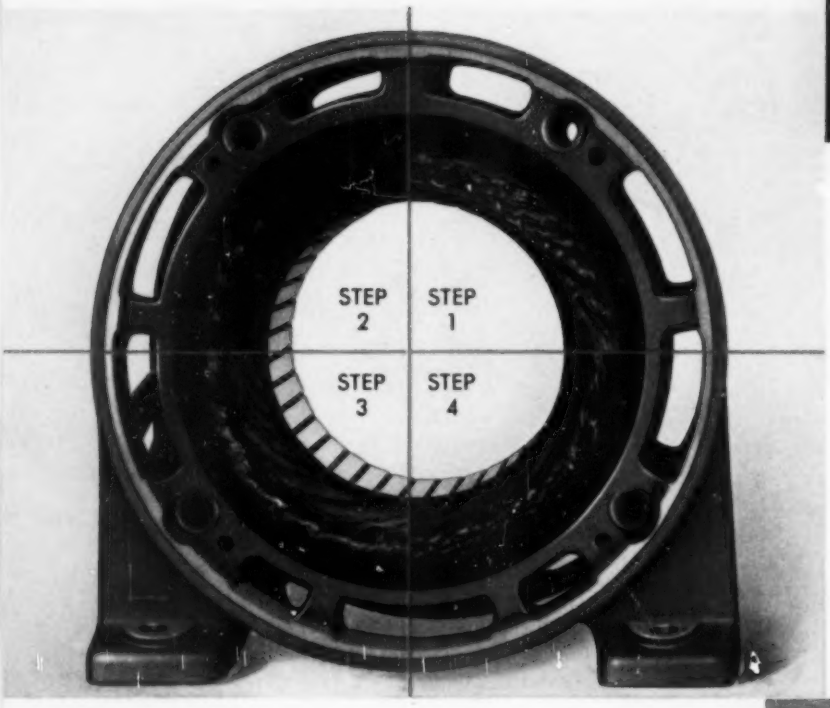

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Step by step, everlasting endurance is built into every U.S. motor by use of asbestos, the only natural fibrous element that cannot carbonize. Four progressive treatments of asbestic compounds are applied plus oven-baking, as follows:

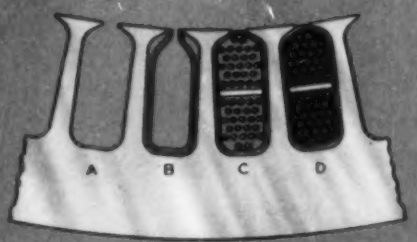
STEP 1 — Synthetic insulated wire wound into coils and inserted in slots lined with sheet asbestos.

STEP 2 — Complete stator is submerged in liquid asbestos insulating compound while pulsating current vibrates wires; then baked. A second dip and further baking follows.

STEP 3 — Plastic asbestos compound is sprayed between and over all end turns, then baked to harden throughout.

STEP 4 — Final spray seals pores; after fourth bake the surface contour is smooth.

U. S. ASBESTIC PROCESS



(A)—Empty stator slot before insulating and winding. (B)—Formed coil of asbestos providing a heat-proof wall of insulation. (C)—Cross section showing wires inserted, with asbestos coil covering entire winding. Asbestos platehoard in center of slot separating and insulating between coils. (D) Asbestocite (in color) forced around windings, penetrates every interstice.

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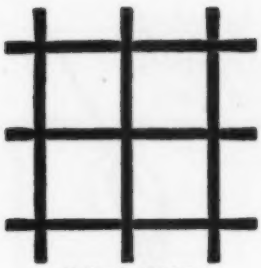
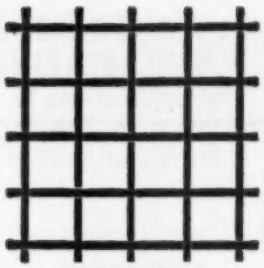
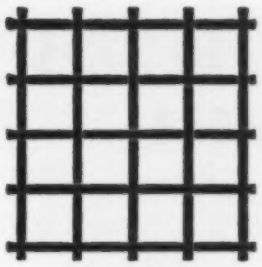


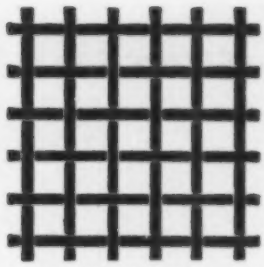
2 Mesh .063"
76.4% Open Area



3 Mesh .041"
76.7% Open Area

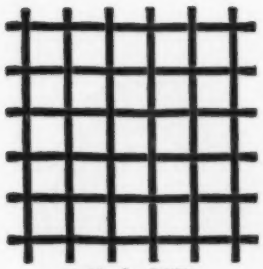


3 Mesh .054"
70.1% Open Area

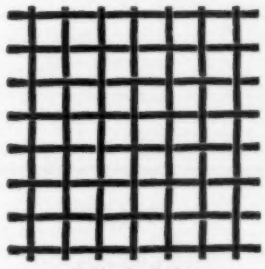


4 Mesh .063"
56.0% Open Area

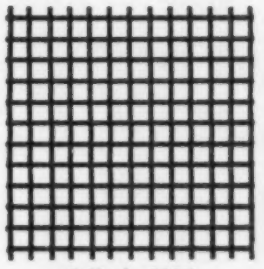
CALL CHASE



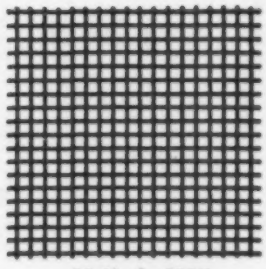
4 Mesh .047"
65.9% Open Area



5 Mesh .041"
63.2% Open Area

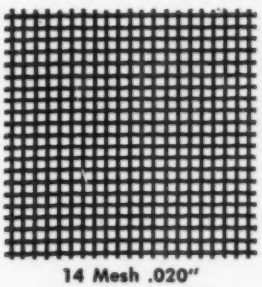


8 Mesh .028"
60.2% Open Area

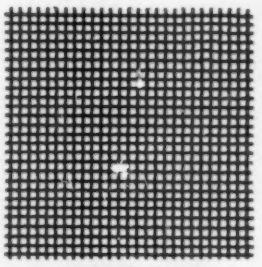


12 Mesh .023"
51.8% Open Area

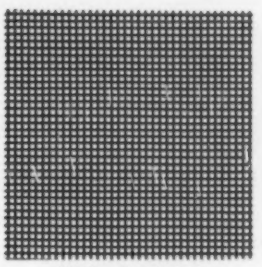
FOR INDUSTRIAL WIRE CLOTH



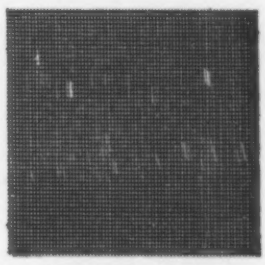
14 Mesh .020"
51.0% Open Area



18 Mesh .017"
48.3% Open Area



24 Mesh .0135"
45.8% Open Area



50 x 40 Mesh .009"
35.7% Open Area

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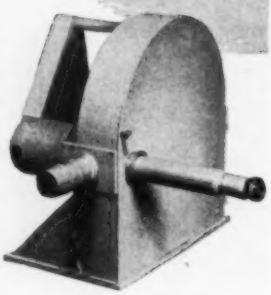

The 8mm FASTAX has a maximum speed range of 12,000 pictures per second . . . the 16mm FASTAX, 6,000 pictures per second . . . the 35mm FASTAX, 2,500 pictures per second. These speeds prevail when cameras are operated on 130 volts *without* a "goose."

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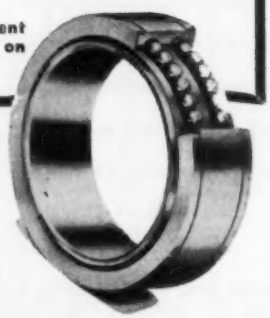

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Heli-Coil* screw thread inserts are precision formed coils of stainless steel or phosphor bronze wire. Wound into tapped holes, they form permanent, non-corrosive, strip-proof threads of astonishing strength. Available for National Coarse, National Fine and Unified threads, pipe threads and spark plug threads. They are made in all standard sizes and lengths for assemblies requiring Class 3, 3B, 2 or 2B fits.

What they are for

AS ORIGINAL COMPONENTS: *Heli-Coil* inserts are used to provide stronger, lighter fastenings, corrosion-proof, wear-proof threads in all assemblies.

FOR PRODUCTION SALVAGE: When conventional tapped holes are damaged in production, restore them on the line with *Heli-Coil* inserts. Get better-than-original strength with no increase in screw size and no tell-tale signs of rework.

FOR SPEEDY REPAIRS: When tapped threads wear, strip or corrode in service, renew them in minutes on location in shop or field with *Heli-Coil* inserts. No welding—no plugging—no secondary machining—no oversize screws.

How they work

Holes are drilled and tapped as you do for ordinary threads—then *Heli-Coil* inserts are wound into tapped holes by hand or power tools. Install in a few seconds, assure thread protection forever. Can be used in any metal wood or plastic.

No other method is so simple, effective and practical.

What they do for you

Heli-Coil inserts *save money* because they strengthen threads and make *fewer* smaller fastenings do the same holding job. They make *lighter* bosses and flanges practical and they *save weight* in two ways: (1) by permitting use of cap screws, instead of bolts and nuts; (2) by allowing use of smaller, shorter, fewer cap screws. *Heli-Coil* inserts *protect* your product from thread wear, galling and stripping for life in every kind of metal, in plastics or wood. They preserve customer good-will by preventing product failure, due to thread fault. *Heli-Coil* inserts improve the end product, cut rejects, salvage threading errors.

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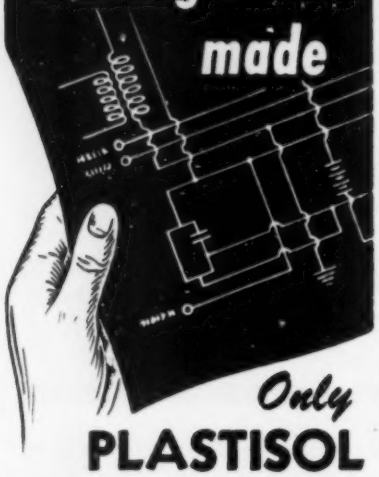

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2. To mount this vertical circuitry, ALDEN PLUG-IN PACKAGES AND CHASSIS give tremendous variety with standard components

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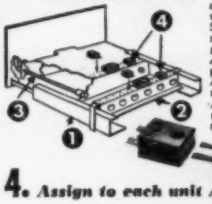

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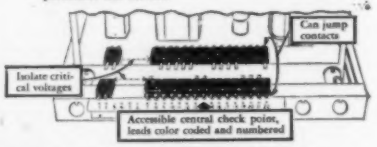

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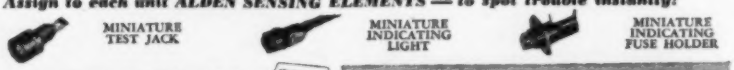

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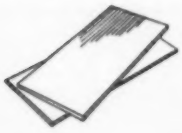

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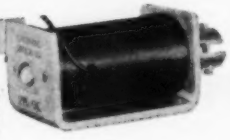
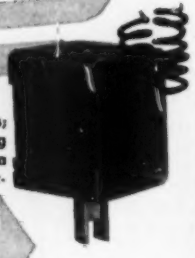


ASCO DC Solenoid—a tapered core, tapered stub, pull type Solenoid. Dimensions: 4¼" long, 2" wide, $1\frac{29}{32}$" high. Available for any standard DC voltage. Pull strength ranges from 1¼ to 11 pounds.



ASCO AC Solenoid for 110 to 440 volts; 25, 50 or 60 cycles with pulls ranging from 18 to 28 ounces at ½" stroke to a maximum of 5 lbs. 4 oz. at 0 stroke. Overall size: 3" long, $1\frac{31}{32}$" wide, 2" high.

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You and all other *Product Engineering* subscribers will find the *HANDBOOK for 1954* even bigger, more valuable, and handier to use than the widely acclaimed *HANDBOOK for 1953.*

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Product Engineering
330 West 42nd St.
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You can trust your tough lubrication job to WEBSTER PUMPS

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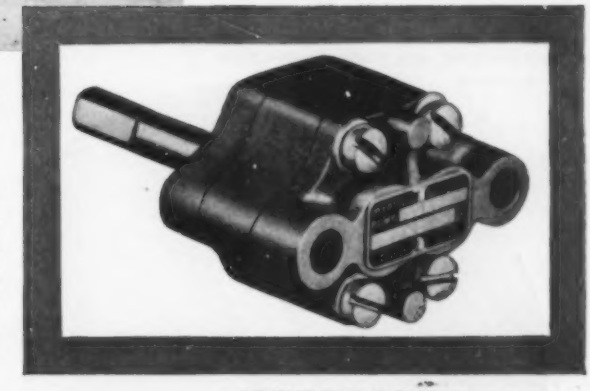

Webster Pumps chosen to furnish lubrication for the Jaeger Air Plus Compressor

● The Jaeger Machine Company's Model 250 Air Plus Compressor is designed to "stand the gaff" of severe conditions—for example, the exploration operation shown above. Here, because of difficulty in obtaining water for mudding shot holes, the Compressors are used to blow cuttings from 5" shot holes, drilled down from 30 to 40 feet—and deliver 250 cu. ft. of air per minute at 100 lbs. pressure!

● WEBSTER Gear-Type Oil Hydraulic Pumps provide these Jaeger Compressors with dependable force-feed lubrication for this unusually tough operation. ... Here at WEBSTER ELECTRIC we make a full line (90 models) of Gear-Type Hydraulic Pumps from 10 gph. to 10 gpm., to operate at pressures up to 1200 psi. at 3600 rpm. or less. Our pumps may be *modified to special installations.*

● Need oil hydraulic pumps for lubricating, oil circulating, filtering, transfer or quiet hydraulic power applications? Consult us, without obligation. Mail coupon today.

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- ✓ Wide selection of porting locations and mounting methods.
- ✓ Integral relief valve optional.
- ✓ Gear contour carefully selected for quiet operation.
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- ✓ Engineered and precision-built for economical performance.
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Pressure (approx.) _____ P.S.I.
Pump Speed _____ R.P.M.
Name and Title _____
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"Where Quality is a Responsibility and Fair Dealing an Obligation"
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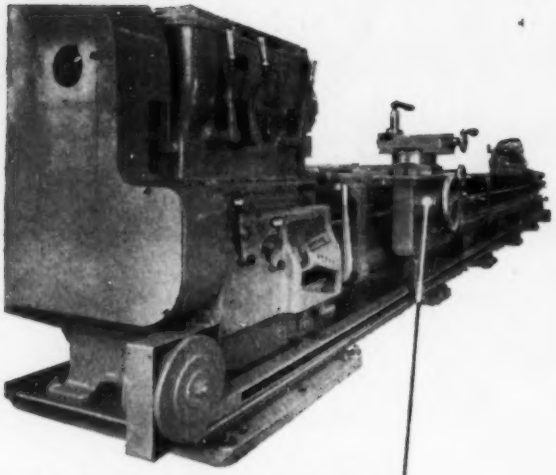
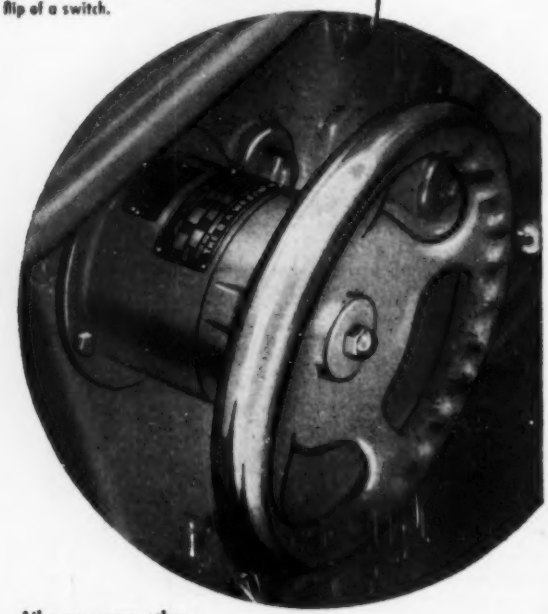


This is a 36" Series F heavy duty engine lathe, one of the fine precision machines produced by The Nebel Machine Tool Company of Cincinnati. A feature of this long bedded beauty is the power operated Rapid Traverse which moves the heavy apron quickly and surely in either direction at the flip of a switch.



Like so many other builders of fine machine tools Nebel called on Wesche to design and produce the torque motor that puts the power on the spot where the power is needed. Specifications called for ½ h.p., 3 phase, 60 cycle, 220/440 volt with a special mounting and special winding to provide the exact torque required.

Wesche Special Motors begin where standard motors stop. Send for catalog outlining our custom motor service which includes data form for easy ordering of special motors. Write:

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- Rugged
- No Rattle
- Rust-proof
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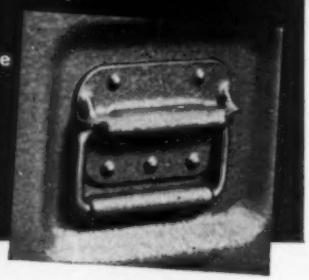

Attention manufacturers of portable equipment, carrying cases, parts boxes, etc.! If your product requires side-carry handles, install the best—the Bendix-Friez handle. This superior handle was developed to meet strict military requirements for many specialized equipment uses. Ruggedly built of aluminum and stainless steel in a sturdy design, it knows no equal for long, faithful service. Can be riveted or welded to any kind of container . . . or depressed in the surface, if desired. Unique "snap-back" feature stops rattle from shock and vibration. Prompt attention to both large and small lot orders. Try us today.

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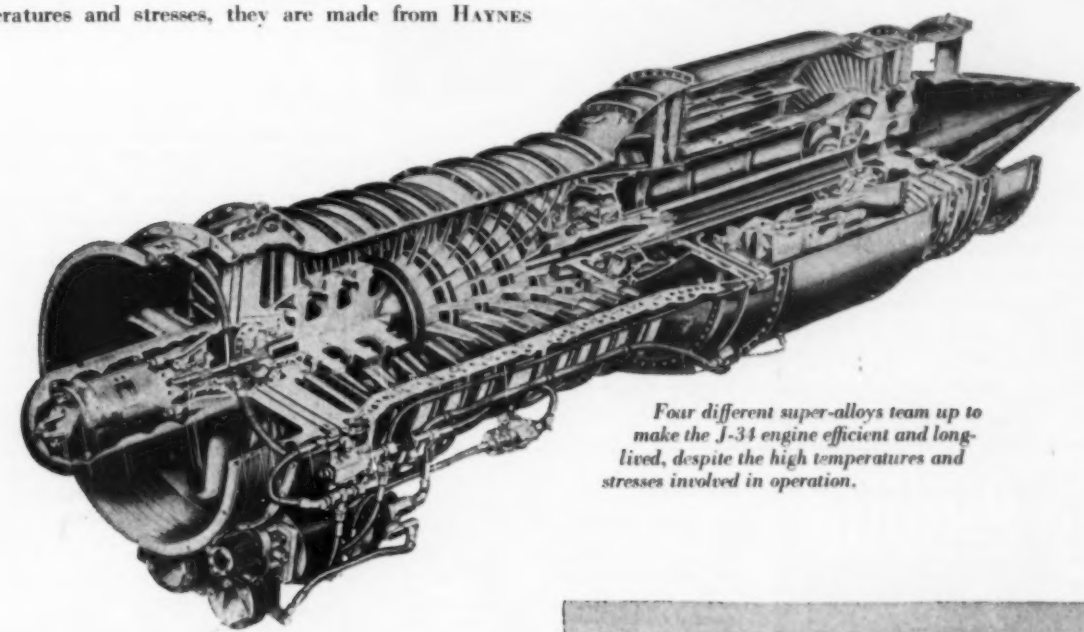
Now you can select alloys for PERFORMANCE

...and disregard fabrication difficulties

When HAYNES precision investment castings are specified, the only consideration necessary in choosing alloys is the service they will give in operation. Virtually any alloy can be cast accurately by this method—even the cobalt-base and nickel-base super-alloys.

The engineers who designed the J-34 turbojet engine took full advantage of this feature of precision castings. They selected four different alloys for the blades and vanes in this power plant—specifying the material best suited to each individual part. Because the blades in the turbine wheel are exposed to extremely high temperatures and stresses, they are made from HAYNES STELLITE alloys Nos. 23 and 31. For the compressor vanes, which are subjected to slightly less severe conditions, Type 347 stainless steel is used. The turbine nozzle vanes are cast from a special alloy made to meet the manufacturer's requirements.

In addition to speeding the production of accurate aircraft parts, HAYNES precision castings have made possible marked savings in the production of machinery parts of all types. For tips on designing parts to be produced by this method, write for the 12-page booklet, "Investment Castings."



Four different super-alloys team up to make the J-34 engine efficient and long-lived, despite the high temperatures and stresses involved in operation.

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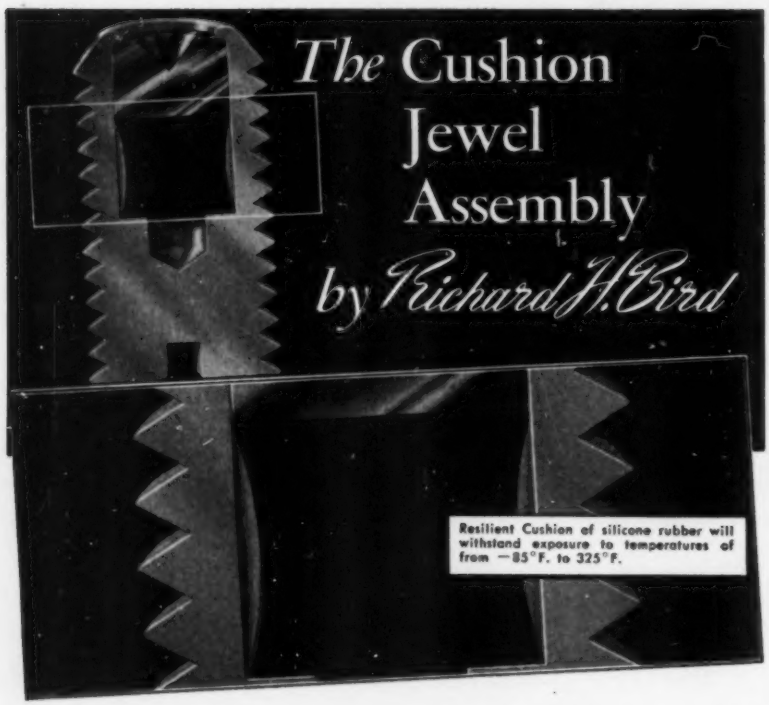
...an entirely new concept of jewel mounting for shock protection


The Cushion Jewel Assembly
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Resilient Cushion of silicone rubber will withstand exposure to temperatures of from −85°F. to 325°F.

Here is your answer to protection for the critical jewel assembly in meters and instruments that must withstand severe shock and vibration conditions. Tests* show that BIRD Cushion Jewel Assemblies perform better and are less subject to damage than conventionally mounted jewels.

Actual assembly line tests show that damage to jewels through improper adjustments by inexperienced operators is practically eliminated when BIRD Cushion Jewel Assemblies are used. And Cushion Jewels are not expensive to use – you can include them in your production for pennies extra, with the added advantage of "protection" for your instruments under all conditions.

Bird Cushion Jewels for shock mounting

- Perform better, provide "protection"
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- Produced in any mounting to specification
- Eliminates damage by inexperienced assemblers
- Controls movement of jewel — no loose assemblies
- Inexpensive shock-proofing for any instrument

* Tests, being conducted at the Squier Signal Laboratories, to compare cushioned and conventional mounts, show that jewels that are cushion-mounted have a better resistance to vibration. Shock tests of instruments using cushion assemblies indicate better performance and less damage susceptibility than instruments using conventionally mounted jewels.

We want to show you how BIRD Cushion Jewel Assemblies can add shock protection to your instruments. A request on your letterhead will bring complete information — or, send us specifications and sizes of jewel bearings in your instruments for samples of Cushion Jewel Assemblies for test *in your plant.*

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TEMPERATURE PROBLEMS IN BEARING APPLICATIONS?

If you do, you can find real help on this subject—as on so many others—in your *Annual HANDBOOK of Product Design for 1953.* An important, carefully detailed report in the *HANDBOOK* explains an empirical formula which enables the designer to specify speed, load, and lubrication requirements so that the bearing operating temperature will fall within safe limits.

Every new edition of your *Annual HANDBOOK* brings you a wealth of *permanently useful* data representing the significant developments of the year in the field of product-design engineering. This data, painstakingly selected from leading technical publications here and abroad, is specially edited for the *HANDBOOK*—sometimes condensed, sometimes expanded, always fully illustrated by photos, graphs, and charts. The *HANDBOOK* is completely indexed, and sectionalized into ten major classifications for easy reference to subject areas of particular interest to you. The report on operating temperature of bearings mentioned above, for example, is just one of many reports in the sixth section, *Design Analysis and Mechanical Parts,* of the '53 *HANDBOOK.*

In Mid-November, you will receive *The Annual HANDBOOK of Product Design for 1954,* even bigger and more informative than your widely acclaimed *HANDBOOK for 1953.* The new edition will again come to you as part of your regular subscription to *Product Engineering.*

Product Engineering

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Bodine has a broad line of dependable motors to solve this problem for you

The coal dust, moisture and corrosive gases found in boiler rooms, plus demanding performance requirements, resulted in about a 90% motor failure record for the basically same damper control now manufactured by the Cleveland Fuel Equipment Co. At that time, it was equipped with a brush type motor. After a thorough analysis and study of the problem, Bodine's local representative and factory engineers prescribed a Bodine Type NCI-12R, totally-enclosed, ball bearing, capacitor motor. Result—years of trouble-free, customer-satisfying service.

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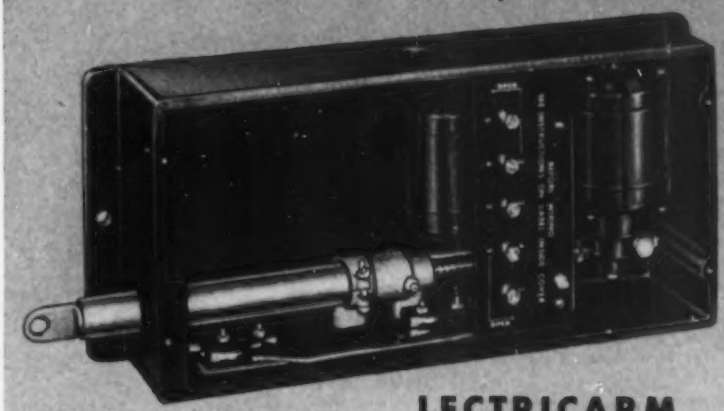
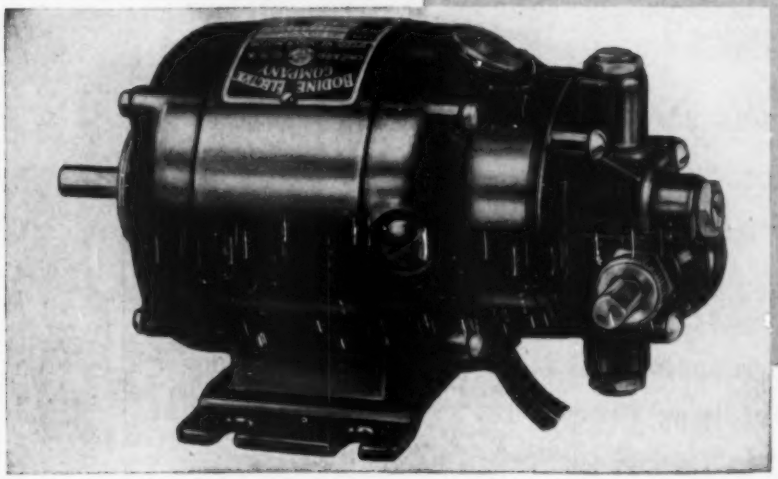


LECTRICARM DRIVE UNIT

Mr. N. F. Hahn, President, Cleveland Fuel Equipment Co., manufacturers of an extensive line of combustion control equipment, selected Bodine motors for these reasons: "... *capable of reversing every few seconds, and we do not know of a Bodine motor that has failed in this respect; dependable and uniform operation; compact; cool running; service free operation.*"



Bodine
FRACTIONAL HORSEPOWER MOTORS
BODINE

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you tell us

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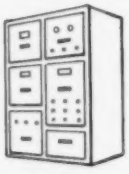
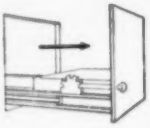
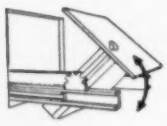
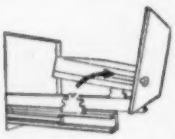




1. The component can slide out fully, easily. Sustains up to 200 pounds per pair. **2.** The component can be tilted and locked at any of several angles, up to plus 90° or minus 90°.





3. If desired, can be entirely removed and returned.

Does this suggest any new applications in your field? Tell us.

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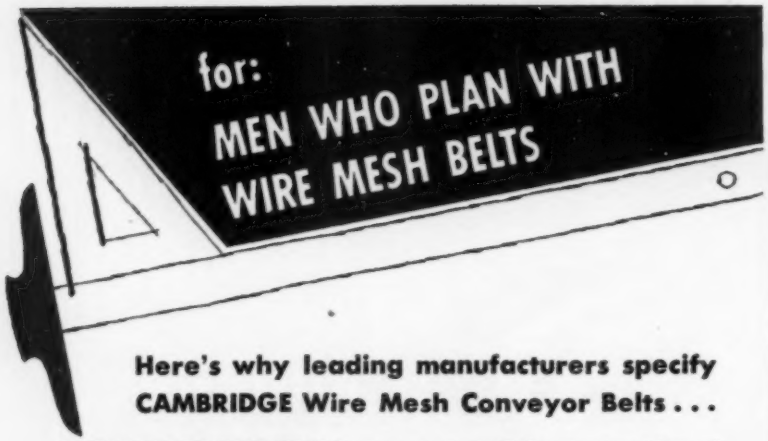

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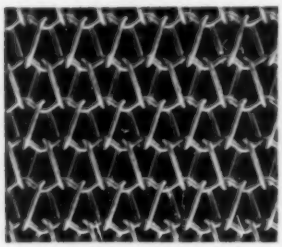

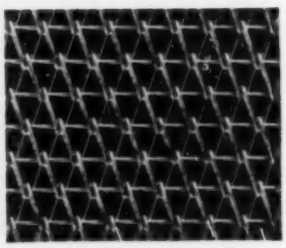

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The Annual

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of Product Design

for 1954

is in production

The Annual HANDBOOK of Product Design for 1954 will be ready in Mid-November. Our special *HANDBOOK* editorial staff, with the full cooperation of all other *Product Engineering* editors, is hard at work on the year-long job of selecting the most significant design-engineering data that is being published in the world's technical press this year.

Indications are that this year's edition of the *HANDBOOK* will be even bigger and more helpful to you than the *1953 HANDBOOK* about which we are receiving so many enthusiastic comments from product-design engineers everywhere.

As before, all editorial material, and related advertisements, will be grouped into ten separate sections, enabling you to locate the information you want on any specific subject quickly. Both the editorial and advertising pages will be thoroughly indexed and, in addition, the 1954 edition will carry a complete editorial index of the *1953 HANDBOOK*.

Again this year, the *HANDBOOK* will come to you as part of your regular subscription to *Product Engineering*.

Product Engineering
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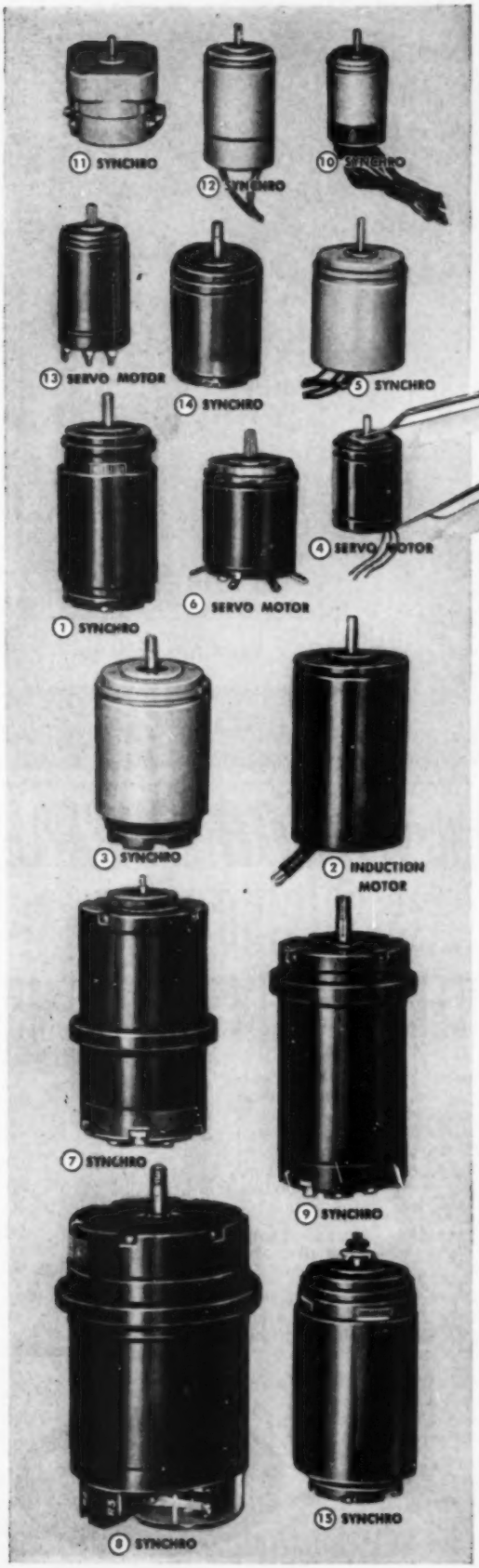
New York 36, N. Y.



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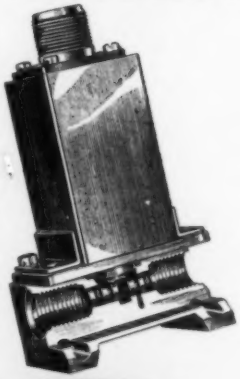
NEW *VALCOR* PRINCIPLE IS SOLVING MORE SOLENOID VALVE PROBLEMS



*Valcor Floating Shear Seal: Simple design eliminates need for precision fits. Seals 100% in both directions . . . and seal improves with use because of self-lapping. Self-cleaning, cannot clog because of exclusive floating shear seal action.

• **Straight-Through Flow:** Absolute minimum pressure drop.

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Valcor Engineering Corp., Carnegie Ave., Kenilworth, N. J.

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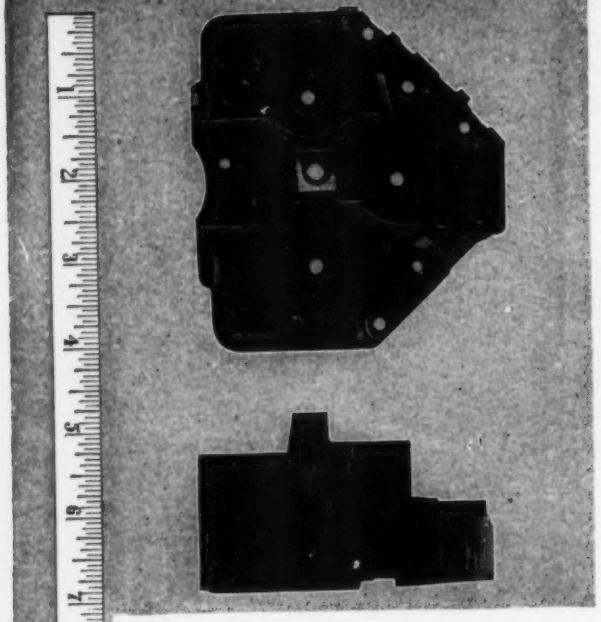

Note the many planes and angles in the pieces shown above — the smooth, perfectly molded surfaces. Only knowledge and experience in selecting the material, expert skill in making the dies, and equal skill in molding can result in finished pieces like these.

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"5400" has a wide range of applications . . . is available with a wide variety of modern dials and knobs . . . can be supplied as an "ON" type of unit on special order.

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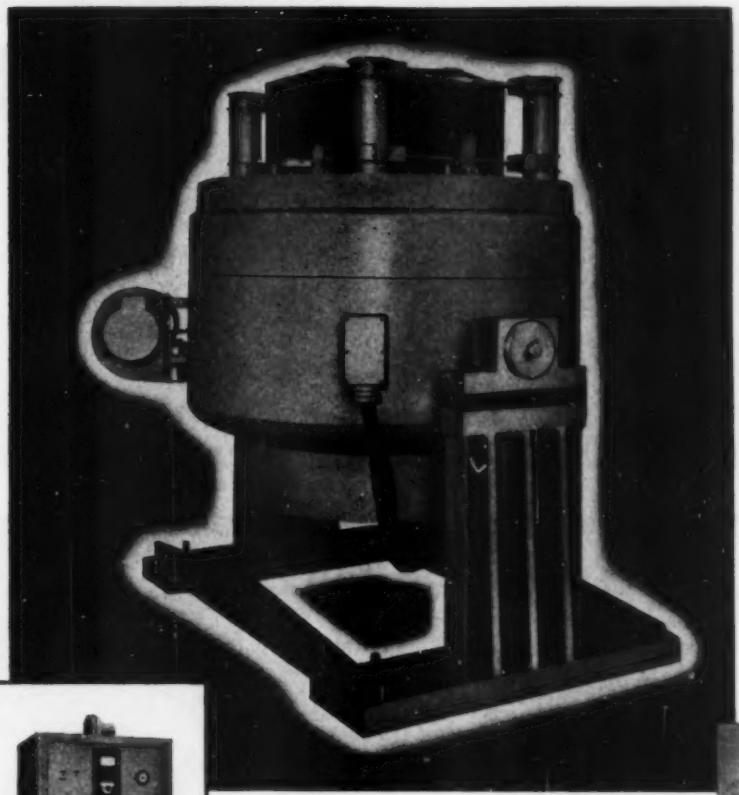
▶ *New MB shaker delivers 10,000 pounds force output!*

▶ *Widens scope of vibration testing to MIL-E-5272 and other specifications!*



HERE's the latest—and the *largest* – vibration exciter ever built for shake testing. Developed by MB vibration specialists, this unit incorporates all the advances made in the last seven years for assuring dependable operation, pure table motion, and absence of resonances. These include specially designed table flexures, forced air cooling, built in protection against overtravel of the table and against misoperation of the equipment.

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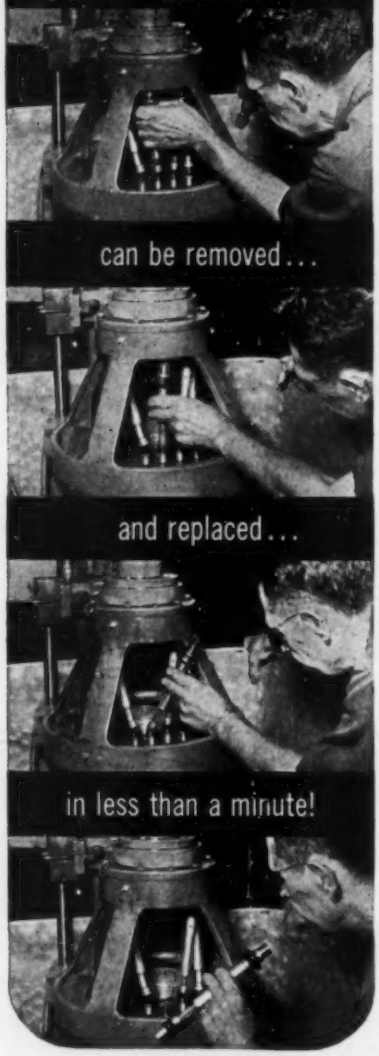

CATALOG 27

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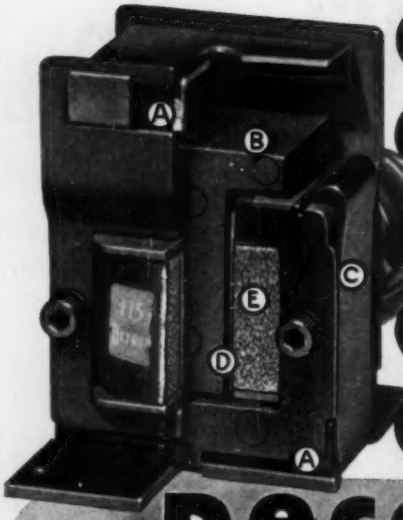

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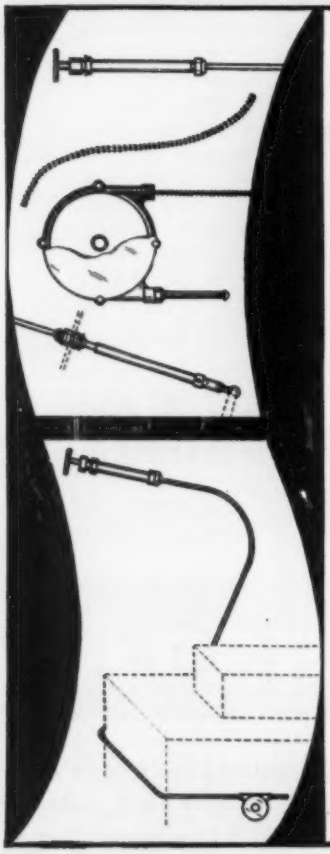

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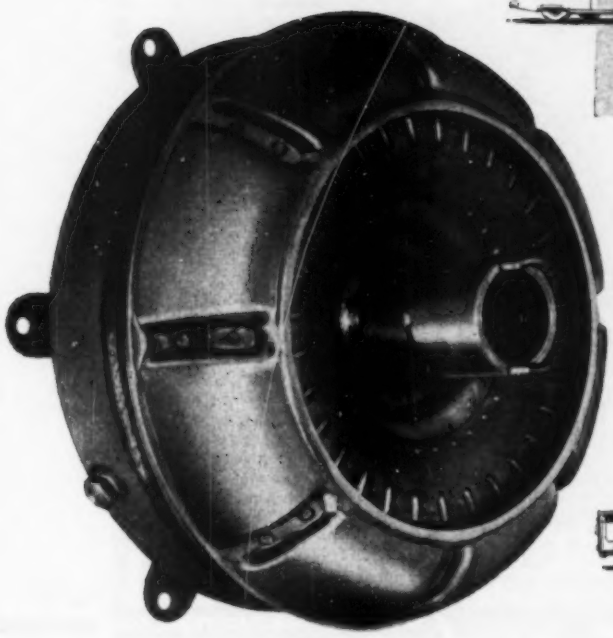

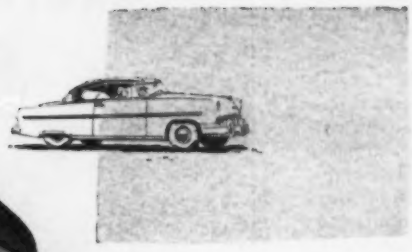

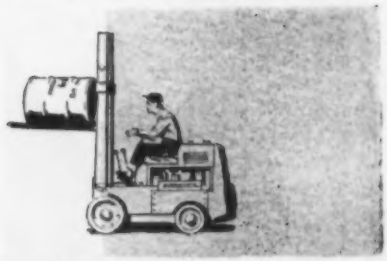

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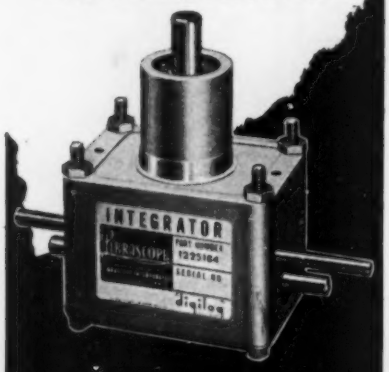

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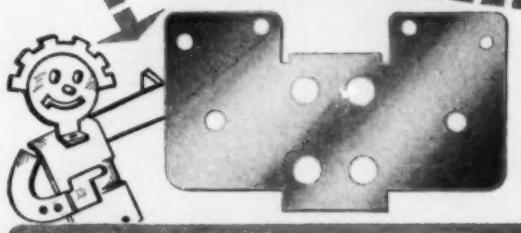

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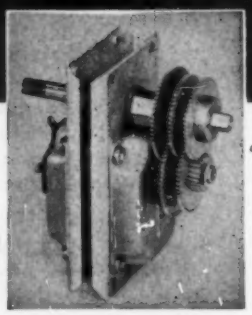

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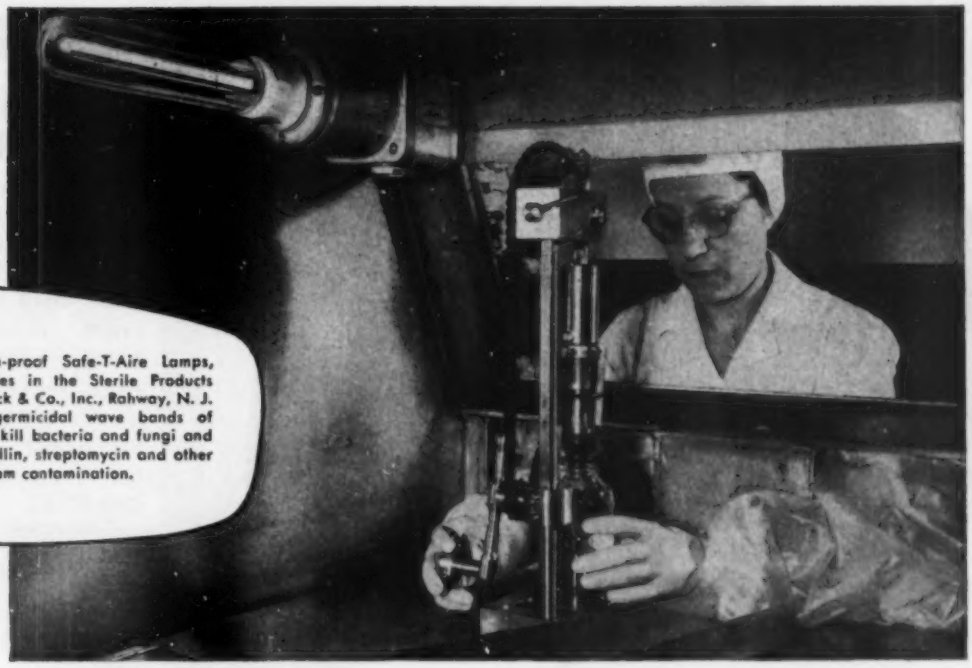

Hanovia Explosion-proof Safe-T-Aire Lamps, installed in cubicles in the Sterile Products Department at Merck & Co., Inc., Rahway, N. J. Lamps generate germicidal wave bands of ultraviolet light to kill bacteria and fungi and help protect penicillin, streptomycin and other "wonder" drugs from contamination.

Glass by Corning makes another product dream come true

Hanovia Chemical and Manufacturing Company, Newark, N. J. faced a materials problem that threatened the development of their explosion-proof germicidal lamp.

The principal use of the lamp is to kill bacteria in areas such as hospital operating rooms and sterile manufacturing sections of pharmaceutical plants. But the light from the lamp includes a high-frequency wave band which produces poisonous ozone and must be filtered out.

Hanovia brought this problem to CORNING and found the solution—a glass jacket for the lamp, which filters out the unwanted wave band and transmits only the ultraviolet bands that have maximum germicidal power. The jacket, made from VYCOR brand glass 7910, is explosion-proof, too, so the lamp can be used in hazardous locations.

VYCOR brand glasses do many things you would never expect of glass. They're 96% silica and have many of the properties of pure fused quartz, but are less expensive. You can plunge them from a furnace at 1800° F., into ice water without fear of cracking. You can use them for high frequency electronic applications, such as in capacitors and resistors. Their design possibilities have scarcely been explored.

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VYCOR brand glass jacket gives lamp four operating essentials:

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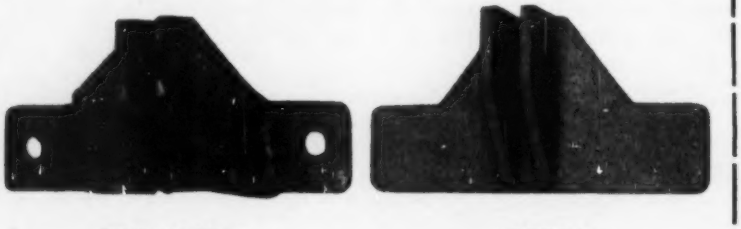

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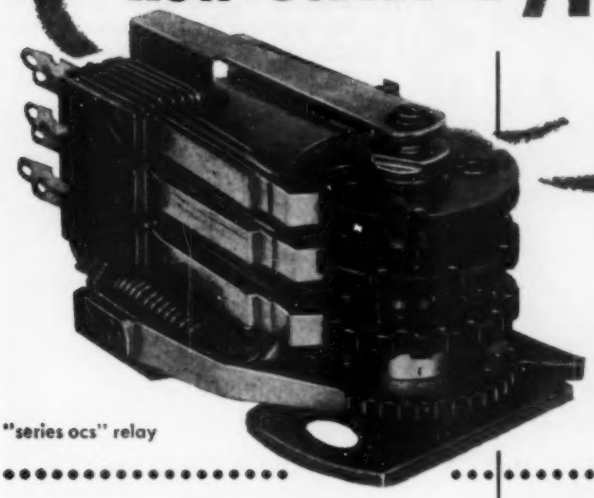
new cam-type relay



"series ocs" relay

"series ocs" combines relay and stepping switch functions

"OCS" RELAY SPECIFICATIONS

cams—Each revolution is divided into 36 steps—any combination of "operated" or "unoperated" intervals can be provided.

contact arrangement—Maximum of 6 contact springs for each of the 3 cams.

spring contacts—Twin contacts. Will make and break load of 150 watts (maximum 3 amps.). "Heavy-duty" single contacts can be provided for higher current.

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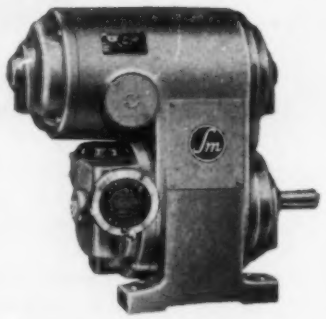

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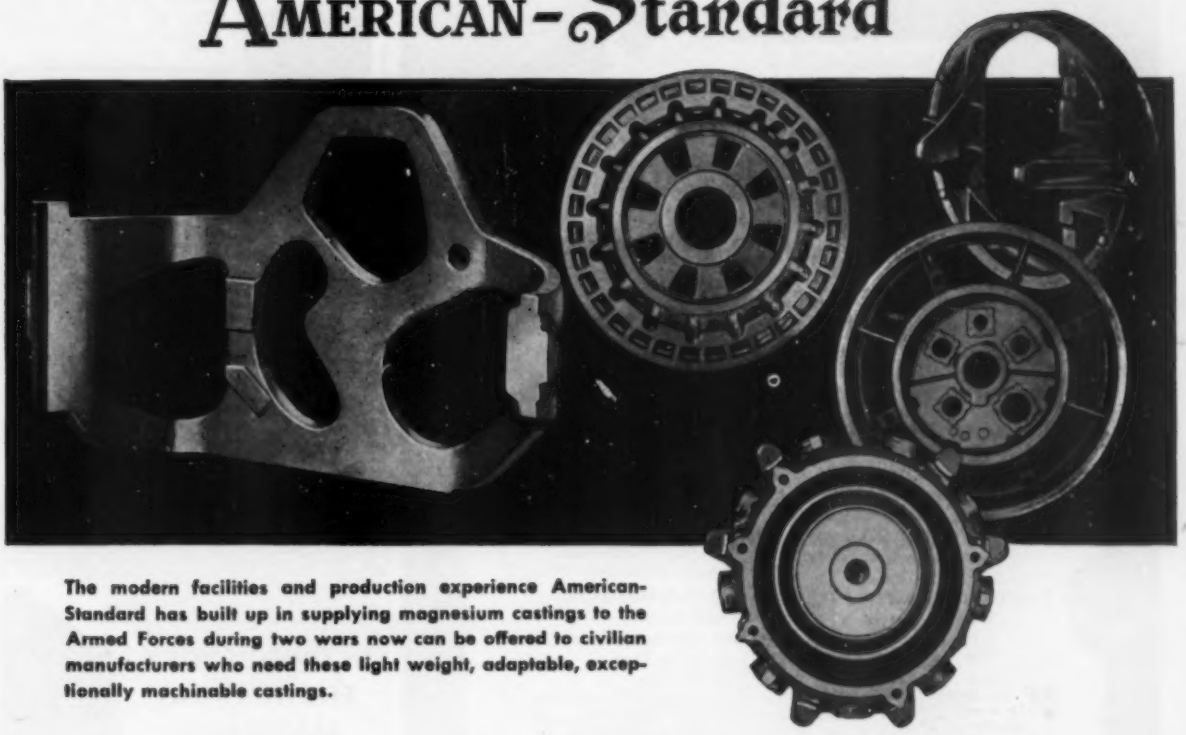

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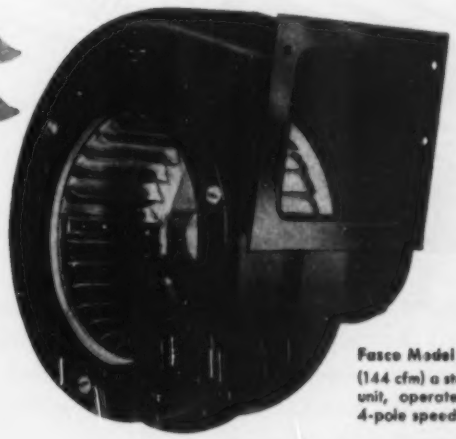
Illustrated are three Fasco shaded pole units, typical of a broad range of motors and motor-blowers which are at their best in fan-duty applications.

The variety of Fasco Motors (2-pole, 4-pole, and 6-pole—from 1/500 to 1/8 hp) and Blowers (from 15 to 275 cfm) is important to you. It can give you added freedom in your design, by offering motors and blowers that will fit into close quarters or operate under difficult conditions. Or it may provide the advantages of a custom-built motor at a mass-production price.

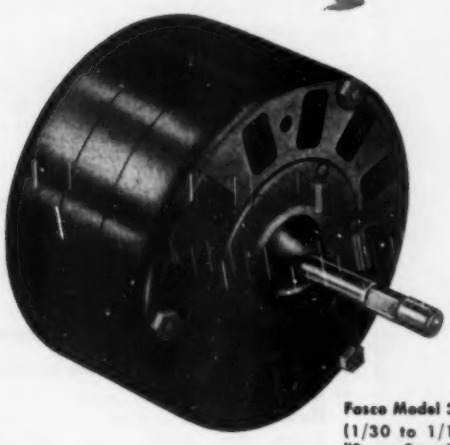
And most important is the engineering service that goes with it. If shaded pole motors will do your job—and they're proving themselves every day in new applications—Fasco engineers will make sure you get just what you want.

To get them started, all you have to do is write a letter.

Fasco Model 6R
(1/225 to 1/50 hp) internally cooled —a useful power source where ambient temperatures are unfavorable.



Fasco Model 5075S
(144 cfm) a sturdy motor-blower unit, operates quietly at low 4-pole speed.



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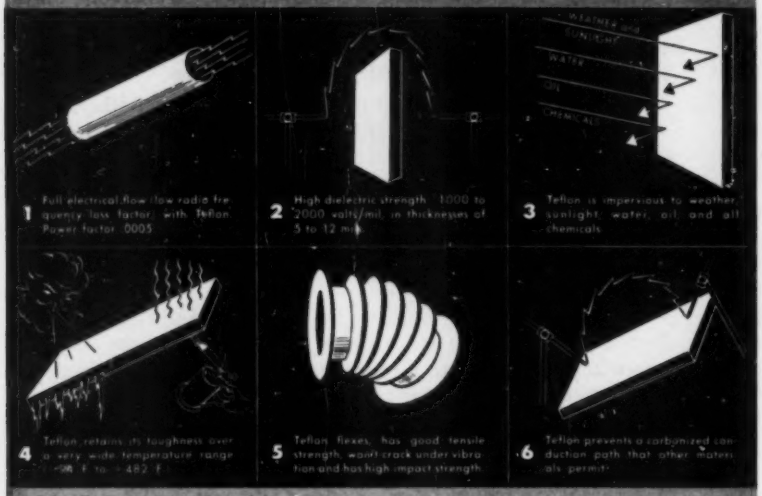

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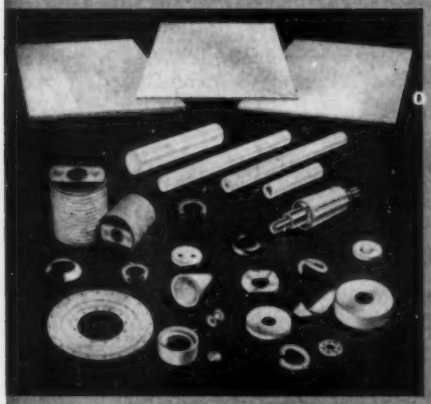

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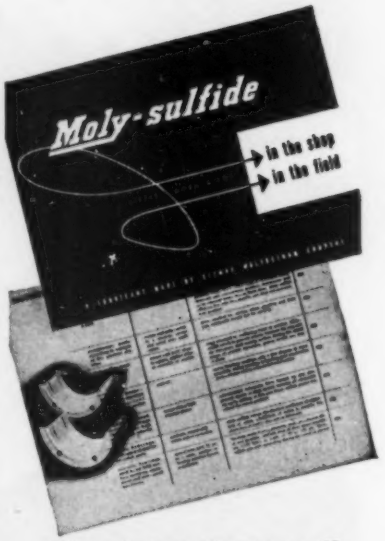

154 varied applications of molybdenum sulfide in the shop and in the field are described in a new booklet now available. This solid-film lubricant has demonstrated unique anti-friction properties under conditions of extreme pressure, high velocity, elevated temperature, or chemical attack.

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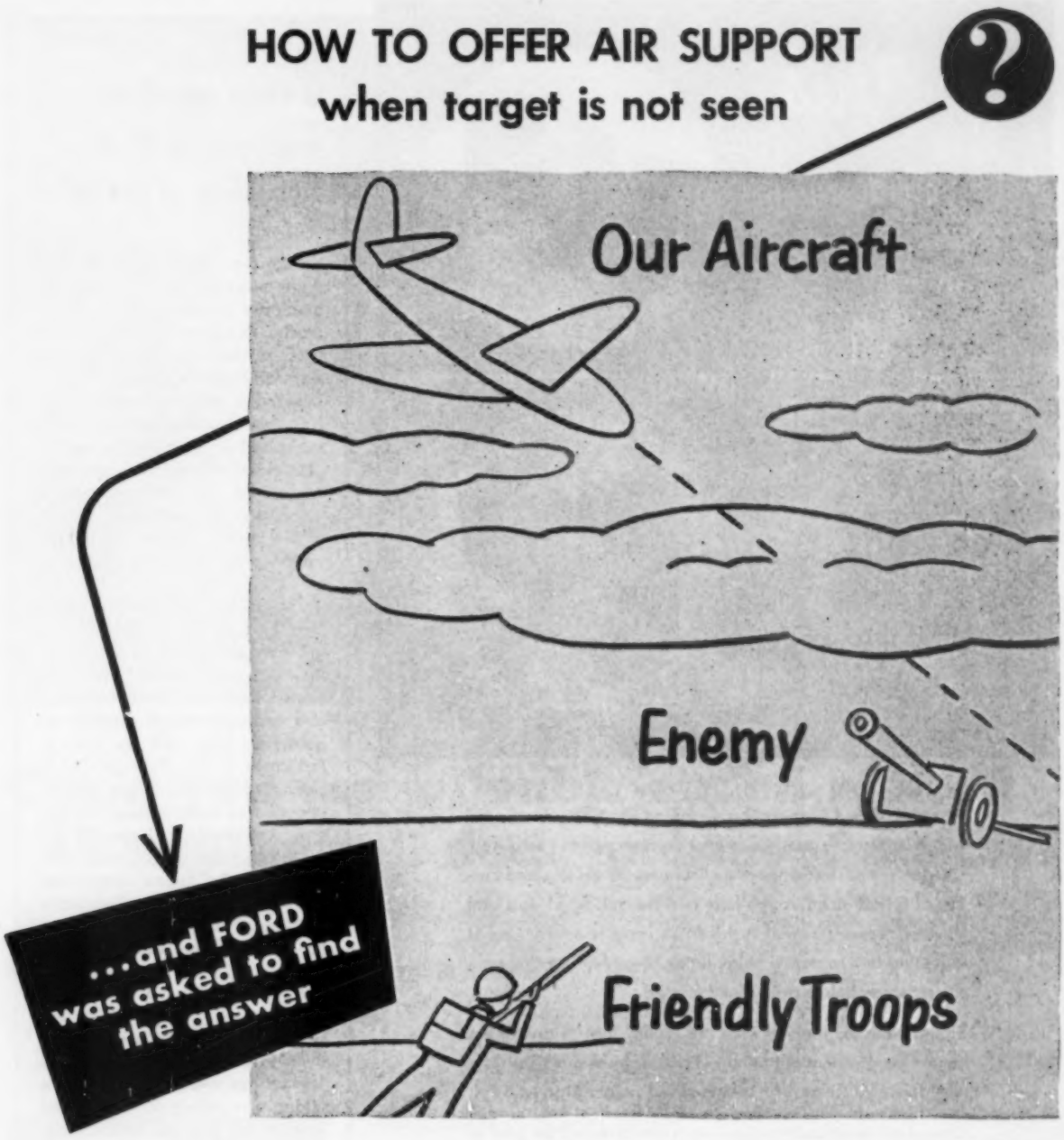

Blinding rain! Darkest night! Obscuring clouds! One of these conditions . . . or all three combined . . . deter planes from seeking out and destroying enemy strong points in support of friendly front line troops. That's why the Ford Instrument Company was called in by the Navy to design and build compact, airborne equipment to do this job.

This is typical of the problems that Ford has been given by the Armed Forces since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

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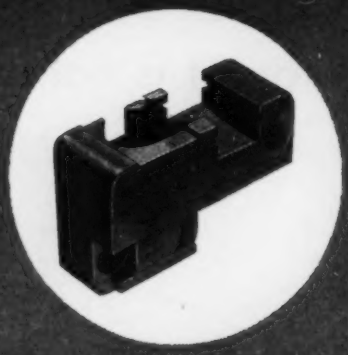

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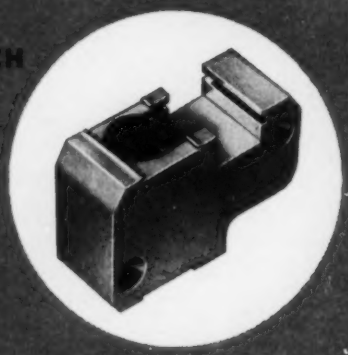

General Bronze Corporation, Garden City, N. Y., discovered that this Hitchiner-cast window lock housing gives completely satisfactory performance and eliminates the drilling and boring of a half-inch through hole and the milling of slots and dovetail recesses as well as the drilling and countersinking of mounting and set screw holes. In the investment casting only the set screw hole is drilled and tapped.

Figure it out for yourself what this saving must be and at the same time give thought to how Hitchiner Investment Castings might save you money on components for your product.

One of our technically trained representatives will be glad to discuss your problem or, if you send us drawings and specifications, we'll give you a complete engineering analysis and recommendations without obligation.

If you want your castings finished to print we can supply them through an associate company.

HITCHINER Manufacturing Company, Inc.
MILFORD 4, NEW HAMPSHIRE
Representatives in principal cities.

Is there any data available on elastic elongation of chains?

Actually, until very recently there has been little or no data available to designers regarding elastic elongation of various types of chains. A report in your *Annual HANDBOOK of Product Design for 1953*, however, for the first time outlines and shows in table and graph form the results of extensive tests to determine accurately the average elastic elongation of single strand ASA roller chain, double pitch conveyor chain, and cable chain.

The *HANDBOOK*, published for the first time last November, has earned the acclaim of design engineers everywhere for its abundance of up-to-the-minute and lastingly useful product engineering data. All the vital information in the *HANDBOOK* is separated into ten major classifications and fully indexed so that you can easily find exactly the data you particularly want. For example, the report mentioned above, titled "Elastic Elongation of Chains," is found in the section on *Power Transmission*.

Another edition will be along to join your '53 *HANDBOOK* in November. *The Annual HANDBOOK of Product Design for 1954* will present an even broader, more informative selection of data important to you in your work. Again, you'll receive the *HANDBOOK* with your regular subscription to *Product Engineering*, at no extra cost.

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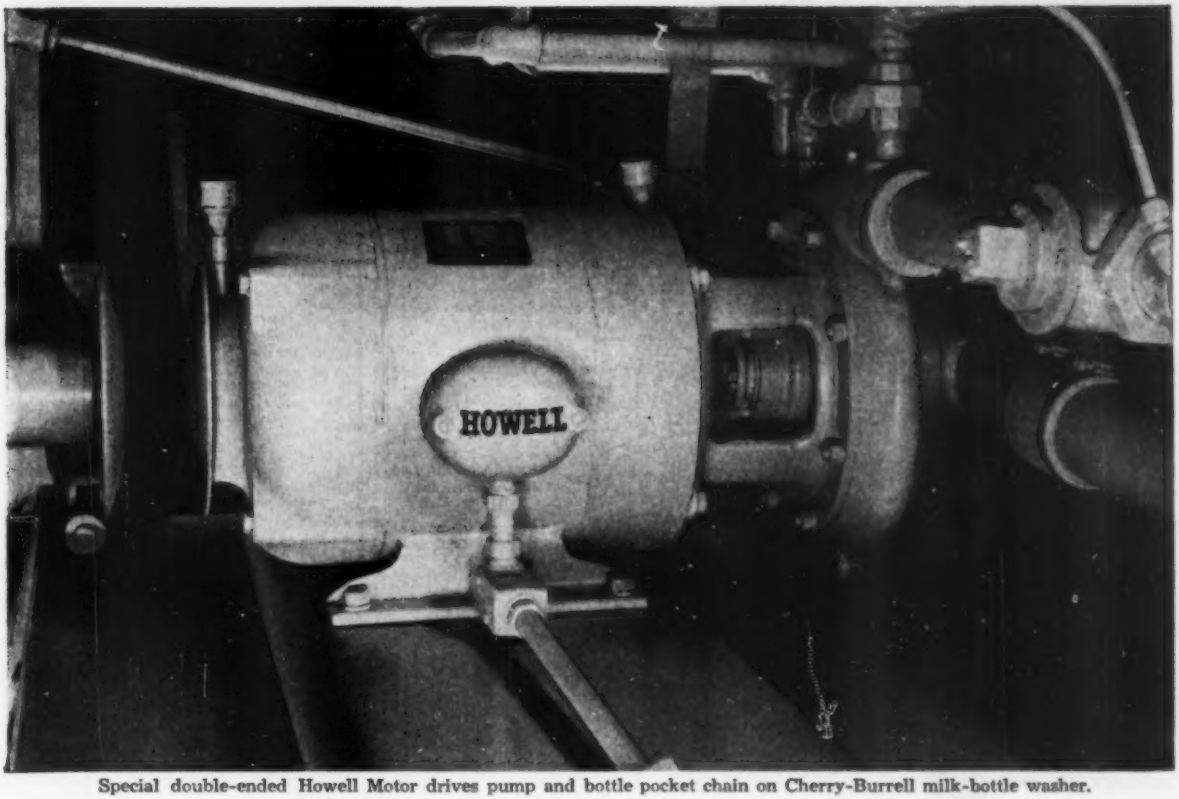
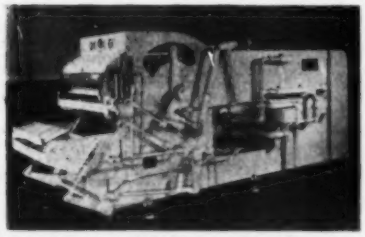


Special double-ended Howell Motor drives pump and bottle pocket chain on Cherry-Burrell milk-bottle washer.

Could you use a double-ended motor? Cherry-Burrell does, and saves money!

The Cherry-Burrell Corporation of Little Falls, N.Y., is a prominent manufacturer of dairy and food-processing equipment. In developing a milk-bottle washer, they needed motors to power the bottle pocket chain and the washing solution pump. They put the problem up to Howell.



The Model "SC" Cherry-Burrell milk-bottle washer handles 48 quart- and 60 pint-bottles per minute.

Howell designers came up with a special space- and cost-saving arrangement — one motor to do the work of two!

They installed a double-ended shaft in a 5-hp, 3-phase, 60-cycle, 220/440-volt, 1800-rpm, type SC motor. On one end, they mounted a special Style C pump flange mounting to which the solution pump was bolted. On the other end, a belt and pulley set-up was fixed to drive the bottle pocket chain.

This compact drive unit was tested on the washer and worked fine. It took the intermittent loads and jogging operation in stride. It has performed perfectly in damp locations.

Could you use a similar double-ended motor in *your* machines or operations? Do you have a tough motor problem of *any* type that needs the attention of Howell designers? We're always at your service with standard or special motors from ⅛ to 500 hp. Call the Howell man in your locality for immediate help.

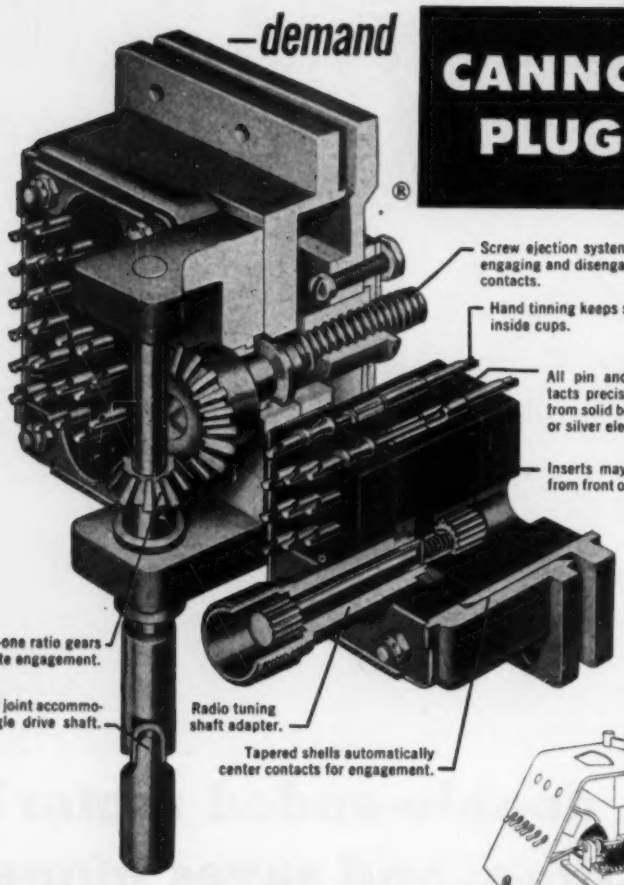
HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

MANUFACTURERS OF PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

Here's why those in the know —demand CANNON PLUGS

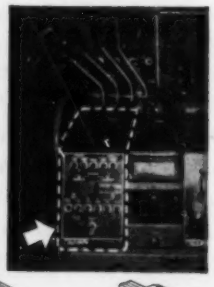

Screw ejection system for engaging and disengaging contacts.
Hand tinning keeps solder inside cups.
All pin and socket contacts precision machined from solid bar stock, gold or silver electroplated.
Inserts may be removed from front or rear of shell.
Two-to-one ratio gears for remote engagement.
Universal joint accommodates angle drive shaft.
Radio tuning shaft adapter.
Tapered shells automatically center contacts for engagement.

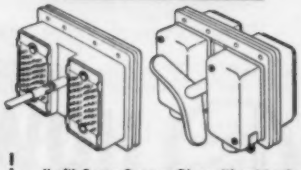
This highly specialized DPD2 Cannon Plug, a member of the DP Series, has its principal use in aircraft instrument panels and remote radio control equipment. But, like many other Cannon Plugs, it has found its way into other fields where the highest quality is needed and where the value of long, trouble-free performance is recognized.

Originally this 2-gang connector was designed to assist in the standardization of radio and instrument assemblies so that such equipment might be interchanged between similar aircraft. It allows for compact design in close quarters with access from the front only. This type of application and variations of the fittings are shown at right. Any Cannon DPD insert may be placed within the shell, with or without tuning shaft, coax, twinax, large or small contacts, provided the separation forces of both halves are similar.

This plug typifies the close attention to important detail that distinguishes every Cannon Plug—the world's most extensive line. If you are looking for real value, regardless of the field you work in, your best bet is Cannon.

Connector is separated by turning slotted shaft here. Complete unit may then be removed from pedestal, shown below.





(Left) Same Cannon Plug without tuning shaft. Straight drive instead of 90° gear. (Right) Similar DPD2 with Dzus wing nut extraction method and junction shells. There are several other variations. Write for details.

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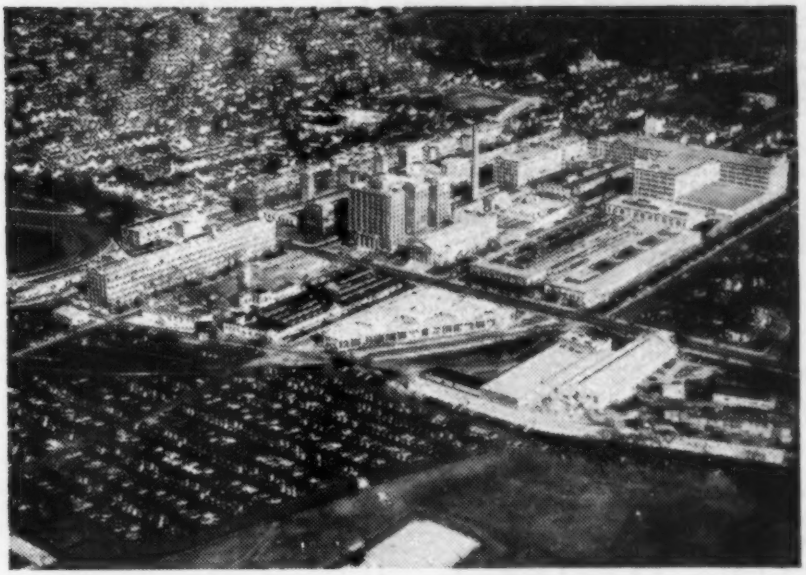

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Index of

PRODUCTS ADVERTISED

In This Issue

•

MATERIALS

Adhesives 108
Aluminum Alloys..33-40, 77-78, 118
Beryllium Alloys..... 371
Bimetal 116, 118
Brass.....2, 94, 257, 341-342, 367
Brazing Alloys 277
Bronze 94, 387
Carbide Alloys 375
Carbon Graphite.....4th Cover
Ceramics 119
Chemicals 8, 332
Copper Alloys..94, 116, 118, 367, 371
Fabrics, Coated or Impregnated 392
Felt 405
Fibre 103, 328
Glass 328, 332, 391
Jewels, Synthetic 376
Laminated Metals....118, 292, 307
Leather .....2nd Cover
Light Metals 379
Lubricants 8
Magnesium Alloys..... 44
Manganese Alloys 118
Molybdenum Alloys 398
Nickel Alloys.....82, 371
Nylon 111
Optical 396
Phosphor Bronze 371
Plastics..6, 79, 111, 272, 311, 332 384
Plastics, Laminated 309
Platinum Alloys..... 118
Powdered Metals.....4th Cover 4, 70, 116, 261
Rubber & Synthetics.....2nd Cover 15, 48-49, 52, 120, 272, 279 300, 344, 409
Silicones 48-49
Silver Alloys 118
Stainless Steel....68, 109, 112, 134 216, 359, 375, 383
Steel...12, 87, 99, 233, 291, 307, 355

STRUCTURAL PARTS

Bars.....70, 77-78, 356
Bushings 321, 356
Castings.....10, 33-40, 98, 123, 246 248, 263, 286, 305, 318, 375, 392 395, 400
Die Castings.....104, 115, 288, 350
Expanded Metals 268
Extrusions 15, 77-78
Forgings.....257, 318, 354
Metal Powder Parts.....4th Cover 4, 70, 116, 261
Plates 77-78, 291
Rods 77-78, 371
Shapes 12, 300
Sheets.....77-78, 120, 134, 371
Stampings 313, 390
Strips.....134, 307, 371
Tubing....2, 46, 68, 92, 99, 105, 112 231, 233, 259, 265, 287, 355
Wire 77-78, 96, 100, 371

FINISHES

Non-Metallic 254
Paints & Lacquers....101, 254, 332
Plating 289
Rust Proofing 254, 289
Sealants 412

MECHANICAL PARTS

Adhesives 108
Axles 258, 301

(Continued on Page 406)

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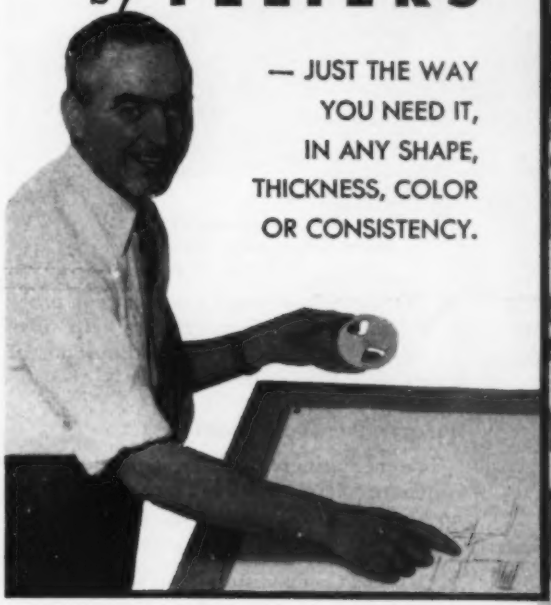

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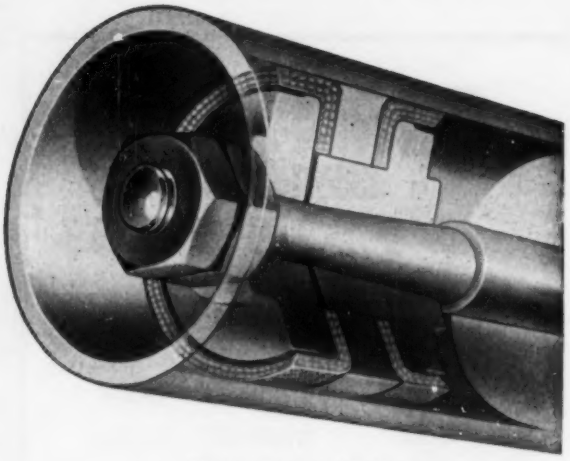
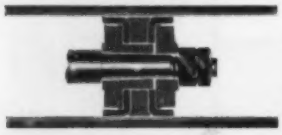


Phantom cutaway showing a typical Pumcup piston assembly.

DIAGRAM OF DARCOVA PUMCUP ACTION (greatly exaggerated)



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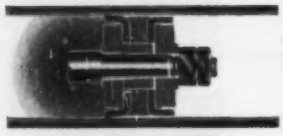

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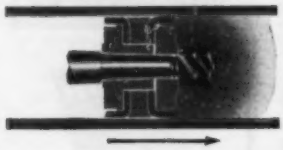

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PUMCUPS

Index of PRODUCTS ADVERTISED In This Issue

(Continued from Page 405)

Balls 294, 334
Bearings, Ball, Roller & Needle..28-29, 42, 47, 50, 55, 58 61, 90-91, 140, 241, 327, 337, 343 352, 368
Bearings, "Oil-less".....4th Cover 70, 261
Bearings, Sleeve.....4th Cover 116, 123, 356, 387
Bellows 60
Belts.....18-19, 52, 336, 380
Bolts, Nuts, Screws & Rivets....53, 59, 63, 80, 88, 106 126-127, 138, 214, 221, 264, 316 333, 364D, 386
Blowers 334
Brakes 239, 299
Brushes 332
Bushings & Grommets..26-27, 116 261, 321
Cameras 368
Chains.....11, 13, 81, 280, 408
Clamps 95, 345
Clips 382
Clutches....239, 299, 300, 302, 331 354, 358
Compressors 18-19, 258
Controls.....64, 282, 358, 388, 399
Counters 17
Couplings, Flexible....32, 260, 304 407
Couplings, Hose & Tube ...95, 347
Dampers 250
Die Casting Machines..... 364
Drives....18-19, 69, 102, Insert Bet. 108-109, 300, 310, 336
Engines 258, 349, 382
Fasteners....53, 59, 63, 67, 80, 88 93, 106, 122, 126-127, 138, 214 221, 264, 266, 316 333, 339, 354 358, 364D, 369, 382, 386
Filters 364A, 411
Flexible Joints 86
Floats 252
Gages & Instruments....56-57, 243 308, 317, 364
Gears....26-27, 114, 247, 262, 388 394
Handles 374
Hose.....136, 295, 347
Hydraulic & Pneumatic Equipment....1, 64, 66, 113, 227 258, 271, 276, 283, 310, 319, 322 351, 358, 364C, 373, 406
Insulation 378
Knives & Blades..... 65
Locks, Hinges..... 312
Lubricating Equipment....41, 51 255, 269, 286, 411, 414
Mountings 250, 407
Name Plates 302
Packings, Gaskets & Seals....2nd Cover, 4th Cover, 72, 95, 97, 223 306, 323, 332, 392, 398, 406
Photographic Equipment..253, 368
Piping 243
Plastic Machinery 107
Power Units.....64, 66, 212, 258 276, 283, 349
Pumps....18-19, 64, 258, 286, 294 312, 315, 351, 364C, 368, 373
Rings.....4th Cover, 67, 223, 323 324-325, 332, 339, 354
Riveting Machines 276
Screw Machine Parts..... 235
Shafting, Flexible 388

Index of PRODUCTS ADVERTISED In This Issue

Sheaves & Pulleys.....18-19 Insert Bet. 108-109
Shims 284
Slides 378
Speed Reducers & Motor Reducers....3rd Cover, 69, 71, Insert Bet. 108-109, 114, 267, 296 364, 377, 394
Springs 374, 382
Sprockets 11, 13, 26-27
Testing Equipment...243, 317, 385
Timers 384
Torque Converters 389
Transmissions 18-19, 81, 102 300, 310
Traps 243, 252
Universal Joints 386
Valves & Fittings....1, 64, 121, 243 252, 271, 283, 286, 322, 324-325 351, 358, 361, 364, 372, 382, 406 411
Vibratory Equipment 385
Vibration Dampers...250, 279, 407
Washers 116, 261
Wire Cloth.....16, 275, 367, 380

ELECTRICAL PARTS

Brakes.....22-23, 239, 297
Brushes .....4th Cover
Clutches 22-23, 239
Connectors 304
Contacts.....54, 118, 252, 370, 402
Controls & Control Equipment.....24-25, 54, 56-57, 84-85 130-133, 212, 229, 256, 260, 262 273-274, 278, 281, 293, 298, 320 325, 357, 370, 372, 385, 390 393 399, 402, 413
Cords 43, 326
Couplings 32
Drives.....71, 130-133
Electronic Equipment.....212, 282 317, 329, 370, 381, 390, 413
Extruded Plastics 245
Generators 249
Instruments.....212, 249, 282, 317 329, 364, 390, 399
Insulation 245, 370, 378
Lamps 340, 370, 413
Magnetos 14
Motors....3rd Cover, 20-21, 30-31 45, 89, Insert Bet. 108-109 117 130-133, 212, 237, 249, 251, 285 290, 295, 344, 338, 353, 360, 365-3 6 374, 377, 390, 394, 397, 399, 401 410, 413
Solenoids....281, 283, 364, 372, 382 386, 402
Thermostats 62, 225, 320
Timers.....56-57, 117, 384, 410
Wire & Cable..... 43
Wiring Accessories....83, 278, 326 370, 402
Drafting Room Equipment & Supplies...253, 270, 292, 302, 334

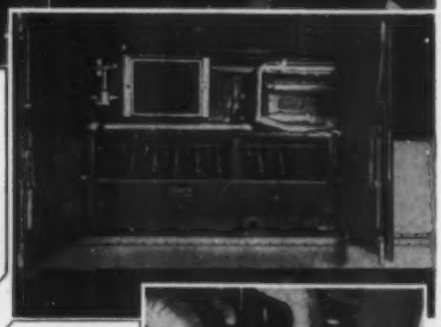
FABRICATING METHODS AND SERVICES

Die Casting 110
Die Making.....110, 346
Drawing 314
Extruding 272
Forming 314
Molding....6, 15, 272, 279, 300, 303 304, 384, 409
Stamping.....110, 314, 390
Swaging 280
Welding.....124, 266, 330

ENGINEERING & PRODUCTION SERVICES

65, 93, 110, 125, 330, 344, 346, 390 409

Books 335, 396



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INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Acme Chain Corp. 408
Acro Mfg. Co. 357
Acushnet Process Co. 279
Adams & Westlake Co. 229
Adel Div., General Metals Corp. 271
Advance Electric & Relay Co. .. 293
Aeroquip Corp. 321
Aetna Ball & Roller Bearing Co. 327
Aircraft-Marine Products Co. ... 83
Alden Products Co. 370
Alemite Div. Stewart Warner Corp. 41
Allegheny Ludlum Steel Corp. . 383
Allen Mfg. Co. 333
Allied Products Corp. 346
Allied Research Products. 289
Allis-Chalmers Mfg. Co. Insert Bet. 108-109
Aluminum Co. of America 33-40
American Blower Corp. 98
American Brake Shoe Co. 10
American Brass Co. 341-342
American Chemical Paint Co. . 254
American Hard Rubber Co. 272
American Insulator Co. 303
American Lava Corp. 119
American Radiator & St. Sanitary Corp. 395
American Screw Co. 80
American Steel Foundries, Inc., Level Load Axle Div. 301
American Steel & Wire Co. 96
American Welding & Mfg. Co. . 330
Amplex Mfg. Co. Div. Chrysler Corp. 70
Anchor Coupling Co., Inc. 95
Apex Machine & Tool Co. 386
Arkwright Finishing Co. 270
Armco Steel Corp. 216
Arrow-Hart & Hegeman Electric Co. 273-274
Atlantic Casting & Engineering Co. 263
Atlantic India Rubber Works, Inc. 300
Atlantic Screw Works, Inc. 80
Automatic Electric Mfg. Co. ... 325
Automatic Electric Sales Co. ... 393
Automatic Steel Products, Inc. . 354
Automatic Switch Co. 372
Automotive Rubber Co. Inc. 378
Avon Tube Div., Higbie Mfg. Co. 265

Baldwin Lima-Hamilton Corp. Standard Steel Div. 318
Bantam Bearings Div., Torrington Co. 61
Barry Corp. 250
Bausch and Lomb Optical Co. . 396
Bead Chain Mfg. Co. 280
Belden Mfg. Co. 326
Belgian Electric Sales Corp. ... 360
Bethlehem Steel Co. 12
Bird Co., Inc., Richard H. 376
Blake & Johnson Co. 80
Bodina Electric Co. 377
Boston Gear Works 26-27
Bound Brook Oilless Bearing Co. 261
Brainard Steel Div. Sharon Steel 355
Breeze Corp., Inc. 345
Bridgeport Brass Co. 94
Brown & Sharpe Mfg. Co. 317
Bundy Tubing Co. 105
Bunting Brass & Bronze Co. ... 356

Cambridge Wire Cloth Co. 380

INDEX TO ADVERTISERS

Cannon Electric Co. 402
Carpenter Steel Co. 109
Carpenter Steel Co. Alloy Tube Div. 68
Cash Valve Mfg. Corp., A. W. .. 361
Central Screw Co. 80
Chain Belt Co. 81
Chase Brass & Copper Co., Inc. 367
Chicago Metal Hose Division .. 136
Chicago Rawhide Mfg. Co. 2nd Cover
Chiksan Co. 86
Chrysler Corp. Industrial Engine Div. 349
Cincinnati Gear Co. 262
Clearprint Paper Co. 334
Cleveland Pneumatic Tool Co. . 227
Climax Molybdenum Co. 398
Columbia-Geneva Steel Div. 92, 96
Comare Electric Co. 260
Consolidated Engineering Corp. 329
Continental Rubber Works 409
Continental Screw Co. 80
Control Products, Inc. 256
Corning Glass Works 391
Coxhead Corp., Ralph C. 292
Crane Co. 243
Crane Packing Co. 398
Cuno Engineering Corp. 364A
Cuyahoga Spring Co. 382

Darling Valve & Mfg. Co. 406
DeLaval Steam Turbine Co. 114
Delco Products Div. Gen. Motors Corp. 89
Denison Engineering Co. 64
Detroit Coil Co. 386
Dexter Folder Co. 312
Dialight Corp. 340
Dings Brakes, Inc. 297
Doelcam Corp. 282
Dow Chemical Co. 44
DuPont de Nemours & Co., Inc., E. I. (Plastics) 111
Durakool, Inc. 262
Dynamatic Corp. Subs. of Eaton Mfg. Co. 32

Eagle Lock Co. 80
Eastern Air Devices, Inc. 338
Eastern Tool & Mfg. Co. 314
Eastman Kodak Co. Industrial Photographic 253
Eastman Kodak Co. Industrial Optical Sales Div. 308
Eastman Mfg. Co. 347
Eaton Mfg. Co., Dynamatic Corp. 32
Elastic Stop Nut Corp. of America 53
Elco Tool & Screw Corp. 80
Electrical Engineering & Mfg. Corp. 353
Electro Dynamics Div. General Dynamics Corp. 255
Electro Engineering Products Co. Inc. 390
Electro Switch Corp. 298

Fairchild Aircraft Div. Fairchild Engine & Airplane Corp. 372
Farval Corp. 51
Fasco Industries Inc. 397
Fawick Airflex Div. Federal Fawick Corp. 299
Federal Bearings Co., Inc. 29
Federal Mogul Corp. (Equipment) 116
Federal Tool & Mfg. Co. 390
Fellows Gear Shaper Co. 107
Felters Co. 405
Fenwal, Inc. 320
Flexonics Corp. 136

(Continued on page 410)

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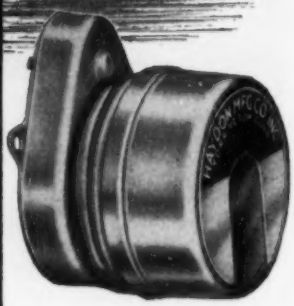

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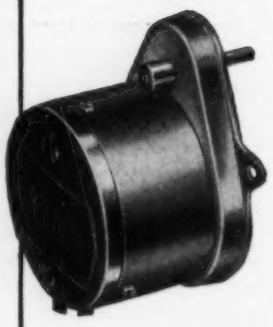
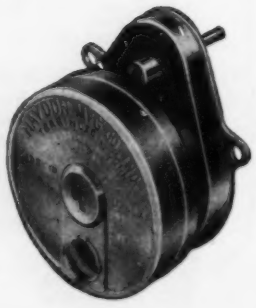


The HAYDON 9200 Series D. C. motor for timing applications is designed for operation from 6 to 30 volts. It can be supplied uncalibrated for use with external resistance or calibrated with resistance type leads.

The 9250F Series HAYDON D. C. motor provides the more uniform torque and speed characteristics of a unit wound for 28 volts, and has an R. F. Interference filter. It offers superior performance over a wide temperature range as well as under load. The current and power drain is lower and no calibration is required.



The 1600 Series is the basic motor of the HAYDON line. This motor offers dependable performance, small size, total enclosure, operation in any position, controlled lubrication, simple assembly and a wide range of standard speeds from 60 to 1/60 rpm. Can be supplied to service specifications.

HAYDON Sales Engineers will gladly demonstrate that HAYDON motors will meet your requirements. Write details of your needs and we will be glad to help.

*TRADEMARK Reg. U. S. Pat. Off.

HAYDON Mfg. Co., Inc.
Subsidiary of GENERAL TIME CORP.

3132 ELM STREET
TORRINGTON, CONNECTICUT

HAYDON
AT TORRINGTON
HEADQUARTERS FOR
TIMING

INDEX TO ADVERTISERS

(Continued from page 409)

Flex-O-Tube, Div. of Meridan Corp. 295
Foote Bros. Gear & Machine Corp. 71
Ford Instrument Co. 399
Formsprag Co. 331
Friez Instrument Div. Bendix Aviation Corp. 374
Fulton Syphon Div. Robertshaw-Fulton 60
Funk Aircraft Co. 300

Garlock Packing Co. 72
Gast Mfg. Corp. 258
Gates Rubber Co. 336
General Dynamics Corp., Electro Dynamics Div. 255
General Electric Co. Apparatus Dept. ...73-76, 130-131, 132-133
General Electric Co. Chemical Dept. Silicones 48-49
General Electric Construction Mats Div. 43
General Industries Co. 285
Gerotor May Corp. 364D
Glidden Co., The 101
Globe Steel Tubes Co. 112
Goodrich Co., B. F. (Rivnut) .. 59
Goodyear Tire & Rubber Co. (Mech. Goods) 15
Grammes & Sons, Inc., L. F. ... 302
Grant Pulley & Hardware Co. .. 378
Gray Iron Founders' Society Inc. 102
Great Lakes Screw Corp. 80
Great Lakes Steel Div. National Steel 87
Gries Reproducer Corp. 386

Handy & Harman 277
Hanna Engineering Works 322
Harper Co., H. M. 80
Hartford Steel Ball Co. 334
Hartwell Aviation Supply Co. . 312
Haydon Mfg. Co. 410
Haynes Stellite Co. 375
Heim Co. 50
Heinze Electric Co. 334
Heli-Coil Corp. 369
Hilliard Corp. 302
Hills-McCanna Co. 286
Hitchiner Mfg. Co. (Metal Products Sales Co.) 400
Holliday & Co., Inc., W. J. 291
Hoover Co. Electric Motor Div 20-21
Houghton & Co., E. F. 323
Howell Electric Motors Co. 401
Hyatt Bearings Div. General Motors 47

Imperial Pencil Tracing Cloth .. 302
Improved Seamless Wire Co. ... 292
Indiana Gear Works 247
International Nickel Co. Inc. ... 82
Irvington Varnish & Insulator Co. 245

Johns-Manville Corp. 306
Johnson Bronze Co. 387
Jones & Laughlin Steel Corp. . 99

KSM Products Inc. 266
Kaiser Aluminum & Chemical Corp. 77-78
Kaydon Engineering Corp. 241
Ketay Mfg. Corp. 381
Klincher Locknut Corp. 221
Kollsman Instrument Corp., Div. Std. Coil. 249
Koppers Co., Inc. Plastics Div. 311
Kraissl Co. 294

INDEX TO ADVERTISERS

Kuhn and Jacob Molding & Tool Co. 384
Kurz-Kasch, Inc. 6

Laminated Shim Co. Inc..... 284
Lamson & Sessions Co.....63, 80
Lear, Inc. Grand Rapids Div... 212
Leland Inc., G. H..... 281
Librascope, Inc. 390
Linde Air Products Co..... 124
Linear, Inc. 332
Link Belt Co.....11, 13, 69, 90-91
Lion Fastener, Inc..... 358
Long Mfg. Div. of Borg-Warner Corp. 389
Lord Mfg. Co..... 407
Lovejoy Flexible Coupling Co.. 304

McGraw-Hill Book Co., Inc.... 396
McLouth Steel Corp..... 359
M B Mfg. Co. Inc..... 385
Mallory & Co., Inc., P. R...4, 54
Master Electric Co. (Speedmaster) .....3rd Cover
Mercury Clutch Div. Automatic Steel Products Inc..... 354
Metals & Controls Corp. General Plate Div..... 118
Metals & Controls Corp. Spencer Thermostat Div..... 62
Metron Instrument Co. 364
Michigan Powdered Metal Products Co. 298
Micro Switch Div. Minneapolis-Honeywell Regulator Co....84-85
Midland Steel Products Co....364D
Milford Rivet & Machine Co... 264
Miller Motor Co..... 113
Miniature Precision Bearings Inc. 58
Minnesota Mining & Mfg. Co.. 108
Minnesota Rubber & Gasket Co. 225
Monsanto Chemical Co..... 79
Mt. Vernon Die Casting Corp. 104
Mueller Brass Co..... 257

National Bearing Div. American Brake Shoe..... 123
National Lead Co..... 110
National Lock Co..... 80
National Lock Washer Co. (Retaining Rings) 339
National Malleable & Steel Casting Co. 248
National Motor Bearing Co., Inc. 97
National Screw & Mfg. Co...80, 106
National Standard Co..... 100
National Steel Corp..... 87
National Tube Div. U. S. Steel Corp. 92
Newark Wire Cloth Co..... 275
New Departure Div. Gen. Motors 140
Ney Co., J. M..... 252
Nicholson & Co., W. H..... 252
Norgren Co., C. A..... 269
Nugent & Co., Inc., Wm. W.... 411

Ohio Knife Co..... 65
Oilgear Co. 351
Orange Roller Bearing Co., Inc. 42
Ortman-Miller Machine Co.... 319

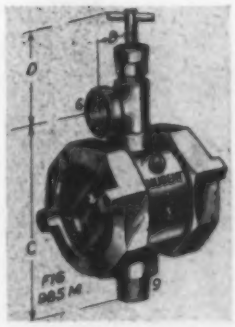
Packard Electric Div. General Motors 45
Parker Appliance Co.....324, 325
Parker-Kalon Corp. ...80, 126-127
Parker Rust Proof Co..... 8
Parker White-Metal Co..... 350
Peerless Electric Co., Motor Div. 237
Penn Metal Co., Inc..... 268

(Continued on page 412)

DESIGN AUTOMATIC POSITIVE LUBRICATION INTO YOUR PRODUCTS with NUGENT LUBRICATING SPECIALTIES

SIGHT FEED VALVES

Sight Feed Valves provide a means of regulating and visually checking oil flow at the point of delivery to bearings, gears, etc. By regulating the Sight Feed Valve, oil flow is controllable from 2 drops per minute up to 21 U.S. gallons per hour. The oil stream through the valve is visible at all times through a removable, dust-proof sight glass. Sizes ¼" to ½" i.p.s. for working pressures to 125 p.s.i.



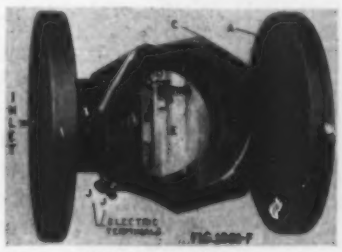
Sight Feed Valve

SIGHT FLOW INDICATORS

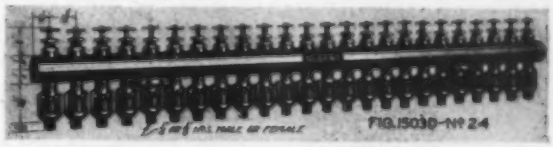
With a Nugent Sight Flow Indicator installed in your lubrication system, you can tell at a glance whether or not oil is flowing properly to vital parts. The Sight Flow Indicator can also be wired with an alarm bell to sound in any desired location —enables you to correct troubles quickly and protect valuable equipment. Windows are removable for cleaning. Sizes from ¼" to 6".

MULTIPLE OILERS

Nugent Multiple Oilers are designed for lubricating enclosed bearings and other hard-to-get-at spots. Oil from a pump or reservoir is piped to the oiler and fed to the bearings by means of tubing through independently adjustable needle valves. Available in a variety of types with any number of feeds.
In addition to lubrication specialties, Nugent offers a complete line of lubrication devices and oil filters. Write for descriptive literature, mentioning the type of equipment you are interested in.



Sight Flow Indicator



Multiple Oiler

Wm. W. Nugent & Co., Inc.
441 N. Hermitage Ave. CHICAGO 22, ILLINOIS

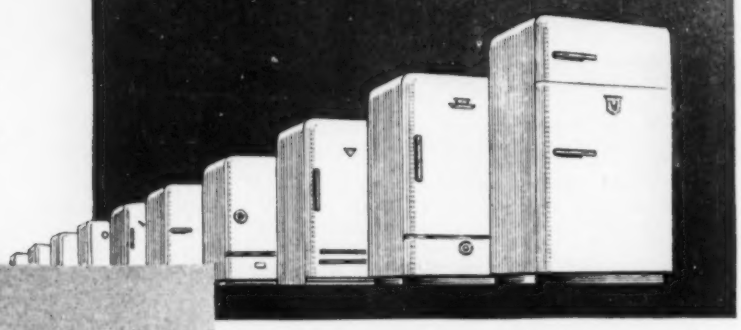
OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Established 1897

PRESSTITE
SEALING COMPOUNDS

Seal in the Efficiency

of Famous Name Refrigerators



. . . by sealing out problems of

MOISTURE · WATER · AIR · DIRT

at joints, seams, breaker strips, doors and lids, spotwelded seams, hinges, screws, bolts

Sealing Compounds, Adhesives and Coatings for

air conditioning, aircraft, appliances, aluminum windows, automobiles, breweries, bridges, cold storage, concrete curing, communications, dams and locks, excavation work, fuel tanks, greenhouses, highways, housing, railroad cars, refrigerators, reservoirs, sewers, storage tanks, trailers, trucks, and many other products and industries.

Leading refrigerator and home freezer manufacturers recognize the importance of tight, permanent sealing for efficient, dependable refrigerator performance. Sealing efficiency *in* begins with sealing moisture-vapor, water, air and dirt *out!*

Standard types of Presstite sealants range from a soft consistency for pressure gun or knife application to a very stiff mastic easily applied with the hands. Some are extruded into tape, ribbon or beads which facilitate application, reduce labor costs.

Over 400 sealing compounds have been developed and tested by Presstite and proved in thousands of applications by scores of industries. Recognized as sealing headquarters, Presstite either has or can formulate the proper sealant to fit your specific requirement.

Seal in the efficiency of your product. Write PRESSTITE for the solution to your sealing problem.

PRESSTITE
SEALING COMPOUNDS

PRESSTITE ENGINEERING COMPANY

3750 Choutean **St. Louis 10, Missouri**

INDEX TO ADVERTISERS

(Continued from page 411)

Perfection Gear Co., American Stock Gear Div. 388
Perkins Machine & Gear Co... 394
Pheoll Mfg. Co..... 80
Pittsburgh Plate Glass Co. Brush Div. 332
Pittsburgh Plate Glass, Fibre Glass Div. 328
Pneu-Trol Devices, Inc..... 358
Power Products Corp..... 382
Presstite Engineering Co..... 412
Product Engineering.....128-129, 362-363
Projectile & Engineering Co., Ltd. 364
Pyro Plastics Corp. 304

Ramsey Corp. 354
Red Bank Div. Bendix Avia. Corp. 413
Republic Steel Corp..... 233 (Steel & Tubes)
Resinite Corp. 378
ReuLand Electric Co..... 290
Revere Copper & Brass Inc.... 2
Reynolds Wire Div. National Standard Co..... 16
Rhode Island Tool Co..... 354
Rhodes, Inc., M. H..... 384
Rigidized Metals Corp..... 379
Riverside Mfg. & Elec. Sup. Co. 278
Riverside Metal Co..... 371
Rivett Lathe & Grinder Inc.... 283
Robbins & Myers Inc.....30-31
Rockford Clutch Div. Borg Warner Corp..... 358
Rockford Screw Products Co... 80
Rogers Corp. 344
Rollway Bearing Co., Inc..... 343
Ross Operating Valve Co..... 1
Ruthman Machinery Co..... 368

SKF Industries, Inc..... 352
Sacks-Barlow Foundries Inc... 392
Saginaw Steering Gear Div., GMC 235
Sandsteel Spring Div. Sandvik Steel Inc. 374
Scaife Co. 300
Schatz Mfg. Co..... 28
Scintilla Magneto Div. Bendix Aviation Corp. Elec'l Conn. 304
Scintilla Magneto Div. Bendix Aviation Corp. H&K Magnetos Div. 14
Scovill Mfg. Co..... 80
Screw Research Assoc. 80
Shakeproof Inc. 80, 214
Simmons Fastener Corp. 122
Skinner Electric Valve Div. Skinner Chuck Co. 364
Smith Corp., A. O. Motor Div.. 296
South Chester Corp..... 316
Southington Hardware Mfg. Co. 80
Spaulding Fibre Co., Inc..... 103
Split Ball Bearing Co..... 368
Sponge Rubber Products Co... 120
Standard Pressed Steel Co.... 88
Standard Tube Co..... 287
Stanley Chemical Co..... 370
Star-Kimble Motor Division Miehle Printing Press & Mfg. Co. 251
Steel Founders' Society of America 305
Stephens-Adamson Mfg. Co.... 337
Sterling Bolt Co..... 80
Sterling Electric Motors Inc... 394
Stevens Mfg. Co., The..... 225
Stewart Warner Corp. (Alemite) 41
Stewart Die Casting Div., Stewart Warner Corp. 115

INDEX TO ADVERTISERS

Strom Steel Ball Co..... 294
Stronghold Screw Products, Inc. 80
Stupakoof Ceramic & Mfg. Co. 335
Superior Steel Corp. 307

Taylor Fibre Co..... 309
Telechron Dept., Gen. Elec. Co. 117
Teleflex, Inc. 388
Tennessee Coal & Iron Div.... 96
Thomas Flexible Coupling Co.. 260
Thompson Products Inc. 121, 310
Timken Roller Bearing Co. (Industrial) 55
Tinnerman Products Inc..... 138
Tomkins-Johnson Co. 276
Torrington Co., Bantam Bearings Div. 61
Torrington Co. (Specialty).... 125
Trabon Engineering Corp..... 414
Transue & Williams..... 313
Tranter Mfg., Inc..... 259
Tri-Clover Machine Co. 315
Twin City Die Casting..... 288

Union Carbide & Carbon Corp.
Haynes Stellite Co. 375
Linde Air Products Co..... 124
UnitCast Corp. 246
United-Carr Fastener Corp.... 93
United Mfg. Co. 258
U. S. Electrical Motors Insert Bet. 364-367
U. S. Graphite Co.....4th Cover
U. S. Rubber Co. 52
U. S. Steel Corp.....92, 96
U. S. Steel Export Co.....92, 96
U. S. Time Corp.....56-57

Valcor Engineering Corp..... 382
Van Huffel Tube Corp..... 231
Veeder-Root Inc. 17
Vellumoid Co. 392
Vickers Inc. 66

Waldes-Kohinoor Inc. 67
Wales-Beech Corp. 80
Warner Elec. Brake & Clutch Co. 22-23
Washington Steel Corp. 134
Webster Electric Co..... 373
Welco Motors 374
Wesche Electric Co., B. A.... 374
Westinghouse Air Brake Co...64-65
Westinghouse Electric Corp...24-25
Wichita Falls Fdry & Mch. Co., Inc. 239
Winsmith Inc. 267
Wollensak Optical Co..... 368
Wolverine Tube Div. Calumet & Hecla Inc..... 46
Worthington Corp. Multi-V Drive 18

■

PROFESSIONAL SERVICES.... 404

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

EMPLOYMENT
Positions Vacant.....402-404
Positions Wanted..... 402
Selling Opportunity Wanted..... 402

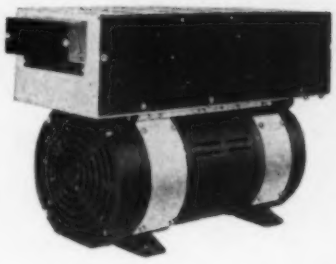
SPECIAL SERVICES
Contract Work..... 404

■

Advertisers' Index starts on 408

Product Index starts on... 405

The most complete line of AIRCRAFT INVERTERS



The Red Bank Division of Bendix Aviation Corporation is the logical place to find your answer to aircraft inverter needs—and for three significant reasons. First, we offer the widest range of inverters. Second, we design and build each inverter as a complete, unified mechanism. Third, we are equipped to design and produce inverters for all kinds of special-purpose applications . . . and, in fact, are now engaged in developing inverters up to 5000 VA and for high temperature, high altitude applications. Our current production models are described below. For complete details on these and also on special-purpose designs, write Aircraft Inverter Section, Bendix Red Bank Division, Eatontown, N. J.

INVERTERS—400 CYCLE OUTPUT

Type Number	INPUT		OUTPUT			Approx. Weight Lbs.	Max. Alt. Feet	Designed to Govt. Part No.
	Volts	Amps	Volts	Phase	VA Rating			
12128	27.5	1	26	1	6	5	35000	AN3496-1 AF
MG-54	27.5	22	115/200	1	250	18	65000	E-51A1A-9 Navy
				3	250			
12142	27.5	22	115	1	250	13	35000	N17158 Navy
				3	250			
12146	27.5	22	115	1	250	13	35000	53B6239 AF
MG-60	27.5	22	115	1	250	17	65000	53B6239 AF
MG-62	27.5	22	115	3	250	17	65000	AN3532-2
32E01	27.5	35	115	1	500	26	50000	AN3533-1
				3	500			
32E00	27.5	45-54	115	1	500	34	50000	AN3534-1
				3	750			
MG-44	27.5	55	115/200	1	750	35	50000	E-52804-2 Navy
				3	750			
MG-57	27.5	100	115/200	1	1250	42	50000	E1737-1 Navy
				3	1500			
MG-61	27.5	100	115	1	1500	51	65000	—
MG-64	27.5	100	115	3	1500	51	65000	—
1518 Mod. 1 & 2	27.5	130	115	1	1500	37.5	20000	—
				3	1800			
1518 Mod. 5	27.5	130	115	1	1500	37.5	35000	—
				3	1800			
32E06	27.5	180	115/200	1	2250	56	50000	E1725-1 Navy
				3	2500			
32E03	27.5	180	115	1	2500	56	50000	AN3516-1
32E09	27.5	180	115	1	2500	56	50000	—
				3	3000			

NOTE: D.C. input voltage shown is a nominal value of 27.5 volts, but all units are designed to operate from 26 to 29 volts. Input Amperes shown are values at 27.5 volt input.

Manufacturers of Special-Purpose Electron Tubes, Inverters, Dynamotors and Fractional D.C. Motors

Bendix DIVISION OF **Bendix** AVIATION CORPORATION

Red Bank

EATONTOWN, N. J.

THE NAME Bendix PRODUCTS MEAN

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

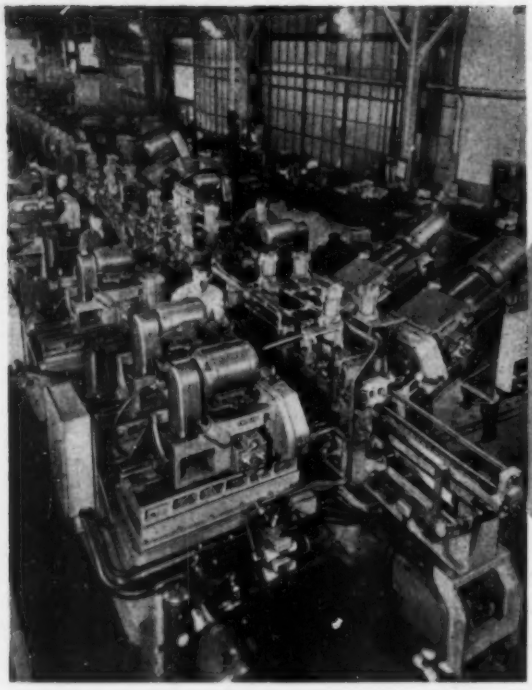


Photo Courtesy Ex-Cell-O Corp., Detroit, Mich.

Trabon

AUTOMATIC LUBRICATION
used on transfer machines
in large automotive plant

this has a BEARING on the subject

Illustrated here are transfer machines typical of several installed in the manufacturing plant of a large automotive producer . . . the first of which was put in operation during the early part of 1951.

Each of these machines is being automatically lubricated with a TRABON system. Two systems cover 195 bearing points each; two, 151 points each; and two, 305 points each.

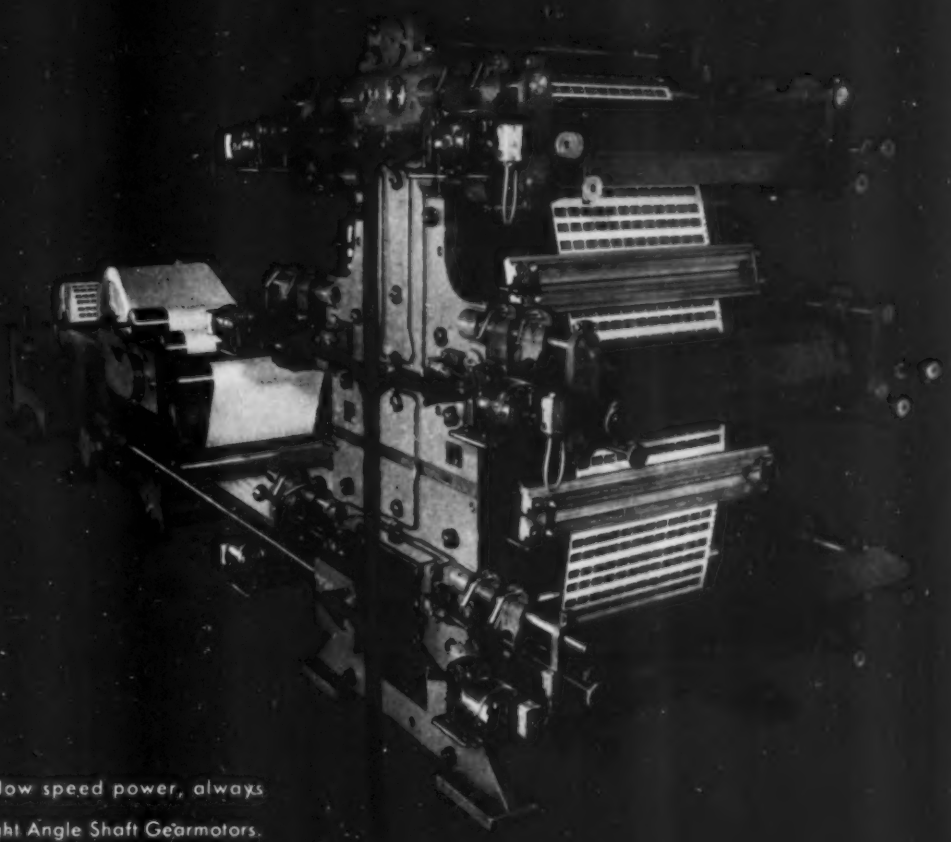
Each system is so proportioned that slides, ways and heavily loaded working bearings receive the proper amount of lubricant every 20 to 30 minutes. All minor bearings on fixtures receive the exact amount of lubricant required every four hours.

Whether your problem is to lubricate a hot metal crane, crushers, ore unloaders, presses, rolling mills, blast furnaces, boring mills, or any other industrial application . . . a TRABON system is your answer.

Completely sealed—positive—hydraulic—handles oil or grease—backed by years of experience.

WRITE FOR BULLETIN 529

Trabon ENGINEERING CORPORATION
1814 E. 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems



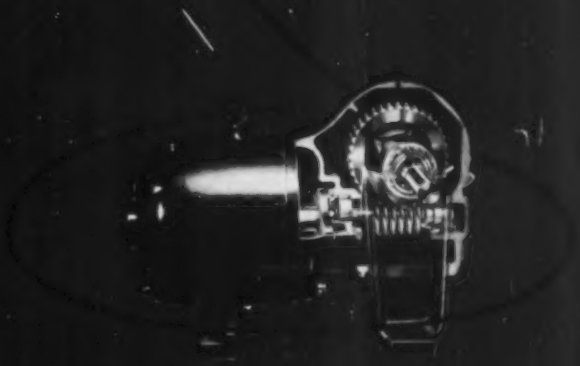
When you must have slow speed power, always consider first MASTER Right Angle Shaft Gearmotors. They're very compact . . . low in cost . . . safe . . . and so easy to use.

And nowhere else can you get anywhere near the wide range of selection that you have in MASTER Right Angle Gearmotors. They're available in sizes 1/8 to 25 Horsepower for all electrical specifications and in splash-proof, enclosed or explosion-proof construction. Gear reduction ranges up to 430 to 1 with the countershaft in either horizontal or vertical positions. In addition these gearmotors can be supplied with integrally built electric brakes . . . three types of variable speed units . . . and with fluid drive units for cushioned power.

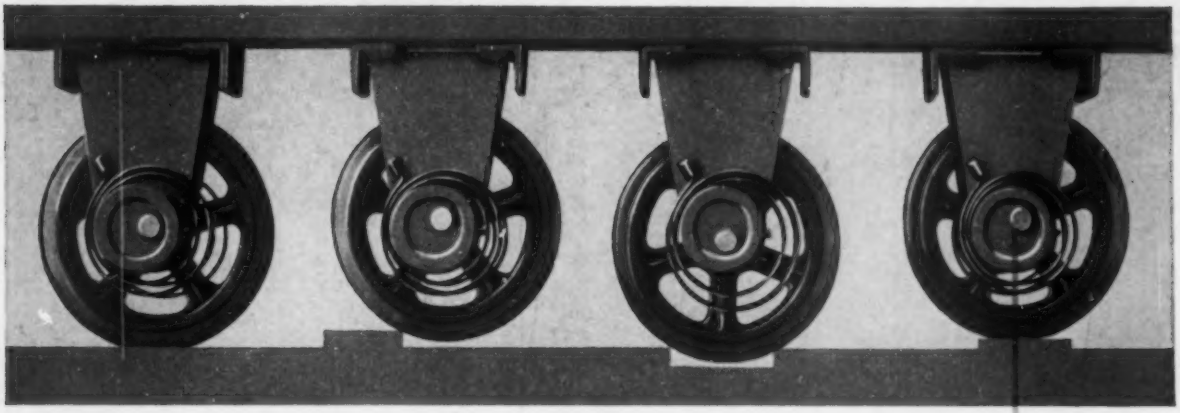
Try them . . . you'll find they're the horsesense way to get slow-speed horsepower.

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO

you can't beat them for compact slo-speed power



GRAMIX BEARINGS in new swinging hub casters help shop trucks roll smoothly over rough, bumpy floors



The new swinging hub caster is designed and built by Standard Manufacturing Company of Mt. Airy, North Carolina, for shop trucks, dollies, trailers and other materials handling equipment. Operating on a clever adaptation of a spring-centering principle, the new caster "steps" over bumps, protecting the cargo it carries from shocks and jolts and providing a smooth, virtually noiseless ride over rough, uneven floors. GRAMIX bearings at the hub of each caster help account for this remarkable performance. These bearings have a porous structure and can be oil-impregnated during manufacture to provide a constant film of oil at the bearing surface, insuring smooth, quiet operation and helping to absorb vibration. Designed for a rated load of 800 lbs. per wheel, the casters consistently carry loads up to 2000 lbs. per wheel with ease. GRAMIX bearings, gears and other parts are compacted from powdered metals under pressures up to 70,000 lbs. and sintered in high temperature furnaces. They can be produced in relatively complicated shapes to tolerances as close as .0005". They need little or no machining thus virtually eliminating scrap loss and waste. GRAMIX parts are strong and tough and will usually outperform and outlast similar machined parts for only a fraction of the cost in production quantities. They can increase the efficiency of your products and perhaps reduce your costs considerably.

98

GRAMIX CATALOG FREE

The new illustrated GRAMIX catalog is full of facts and figures, charts and data that tell you all about GRAMIX parts. Chances are it will suggest many ways in which GRAMIX parts can improve your operations. Write us today for your free copy.

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